

**KOSTUCH ENGINEERING LIMITED**

**FOUNDATION INVESTIGATION AND DESIGN REPORT**

**W.P. 82-91-00**

**FILL EMBANKMENT IN SETTLEMENT AREA**

**HIGHWAY 401/CPR OVERHEAD**

**STRUCTURE REMOVAL, CORNWALL, ONTARIO**

**DISTRICT 41, KINGSTON**

**MINISTRY OF TRANSPORTATION ONTARIO**

**PROJECT NO. ONO11284**

**FOUNDATION INVESTIGATION AND DESIGN REPORT**

**TO**

**KOSTUCH ENGINEERING LIMITED**

**ON**

**W.P. 82-91-00**

**FILL EMBANKMENT IN SETTLEMENT AREA  
HIGHWAY 401/CPR STRUCTURE REMOVAL  
CORNWALL, ONTARIO**

**DISTRICT 41, KINGSTON  
MINISTRY OF TRANSPORTATION ONTARIO**

**Jacques , Whitford and Associates Limited  
2781 Lancaster Road, Suite 200  
Ottawa, Ontario K1B 1A7  
Tel: (613) 738-0708  
Fax: (613) 738-0721**

**February 2001**



# TABLE OF CONTENTS

1.0 INTRODUCTION .....	1
2.0 SITE DESCRIPTION AND GEOLOGY .....	1
3.0 INVESTIGATION PROCEDURES.....	2
3.1 Field Program.....	2
3.2 Laboratory Testing.....	3
4.0 SUBSURFACE CONDITIONS .....	3
4.1 Silty Sand/Sand (Fill).....	4
4.2 Organic Deposit .....	4
4.3 Clay .....	4
4.4 Silty Sand, and Sand and Gravel (Till) .....	5
4.5 Bedrock.....	6
4.6 Groundwater .....	7
5.0 CLOSURE .....	7
6.0 PROPOSED DEVELOPMENT.....	8
7.0 PEAT REMOVAL.....	9
8.0 EMBANKMENT OPTIONS .....	9
8.1 Conventional Embankment.....	10
8.2 Light Weight Fill Embankment .....	13
8.3 Wick Drains .....	14
8.4 Removal of Clay Layer.....	14
8.5 Embankment Construction Prior to Structure Removal .....	15
8.5.1 Peat Removal .....	15
8.5.2 Foundation Response to Embankment Construction Beneath the Bridges .....	16
8.5.3 Structure Removal .....	20
8.5.4 Monitoring Requirements .....	21
9.0 DISCUSSIONS.....	21
10.0 RECOMMENDATIONS.....	23
10.1 Culvert Construction.....	23
10.1.1 Design Considerations .....	23
10.1.2 Foundation Recommendations.....	23
10.1.3 Lateral Earth Pressures .....	24
10.1.4 Construction Recommendations .....	25
10.2 Peat Removal .....	27

10.3	Excavations.....	27
10.4	Site Preparation.....	28
10.5	Dewatering.....	28
10.6	Wick Drain Installation.....	28
10.7	Embankment Construction.....	29
10.8	Duct Work.....	29
10.9	Instrumentation .....	30
10.10	Erosion Control.....	30
10.11	Frost Protection.....	30
11.0	CLOSURE .....	31

Appendix 1	Explanation of Terms Used in Report Borehole Records Figure 1- Plasticity Chart Figure 2 - Atterberg Limits, and Shear Strength vs Elevation Figures 3 through 6 - Consolidation Test Results
Appendix 2	Drawing 11284-FE1 - Key Plan & Borehole Location Plan Drawing 11284-FE2 - Stratigraphic Cross-Section
Appendix 3	Figure 7 - Settlement Along WBL Figure 8 - Settlement at Sta. 27+850 Figures 9-11 - Settlement/Time Curves Figure 12 - Settlement/Time Curve, Pile Cap Effect
Appendix 4	Drawing 11284-FE3 - Peat Removal Limits Drawing 11284-FE4 - Wick Drain Limits and Spacing Drawing 11284-FE5 - Culvert Backfill Drawing 11284-FE6 - Pile Cap Backfill
Appendix 5	Special Provisions Light Weight Fill Wick Drains





# FOUNDATION INVESTIGATION REPORT

For

**Fill Embankment in Settlement Area**

**Cornwall, Ontario**

**W.P. 82-91-00**

**Highway 401/CPR Overhead Structure Removal**

**District 41, Kingston**

## 1.0 INTRODUCTION

This report presents the results of a foundation investigation carried out for the proposed construction of fill embankments to replace the abandoned C.P.R. Structure (Site 31-214) located along Highway 401, in Cornwall, Ontario.

The work was carried out under Agreement No. 4005-A-000045 and in general accordance with our proposal dated October 26, 1999. Authorization to proceed was provided by Mr. J. Johnston, P.Eng., of Kostuch Engineering Limited (Kostuch).

This report contains the factual information obtained from the field and laboratory investigation.

## 2.0 SITE DESCRIPTION AND GEOLOGY

The project site is located on Highway 401 within the municipal boundaries of Cornwall between Stations 27+700 and 28+000. The site location is shown on the Key Plan portion of Drawing No. 11284-FE1 in Appendix 2.

This area is in the physiographic region identified by Chapman and Putnam (1984) as the Lancaster Flats where overburden generally consists of clay to very fine sand over glacial till over bedrock. Soils are generally thin with the exception of a few small areas of deep deposits.

Bedrock underlying the site generally consists of interbedded calcarenite and sublithographic to fine crystalline limestone and shale of the Bobcaygeon Formation.

Highway 401 has a four lane rural cross-section. Twin eight-span structures are present where Highway 401 crosses over the now abandoned CPR line on a 43 ° skew. The approach fills are approximately 9 m in maximum height over the surrounding terrain. Boreholes from previous investigations in 1958 indicate variable conditions within this section from peat to silty clay. The construction records indicate that a flat stabilizing berm was constructed around the approach fills as an apron extending as much as 45 m from the abutments.

The structures are supported on H piles (250 x 62) which are understood to be end bearing on bedrock.

The existing highway embankment slopes are vegetated with short grass. Short and tall grasses in wet marshy areas are present on both sides of the highway. The abandoned CPR line has a sand and gravel surface through the marshy areas.

It is noted that an underground fibre optics cable runs parallel to the highway on the south side of the East Bound Lanes.

Drainage in the immediate area is provided by culverts near Stations 27+855 and 27+870 which direct water from the south to the north and ultimately to the St. Lawrence River via Grays Creek.

### **3.0 INVESTIGATION PROCEDURES**

#### **3.1 Field Program**

The field work for this investigation was carried out in December 1999. The subsurface conditions were investigated through a borehole drilling program. A total of thirty seven (37) boreholes, numbered 99-1 to 99-40, (excluding 99-19, 99-20 and 99-22) were advanced at select locations to depths ranging from 3.7 to 16.8 m below the existing ground surface.

The boreholes were drilled using a CME 55 power auger drill suitably equipped for soil and bedrock sampling. Hollow stem auger equipment was used to advance the boreholes in the overburden. Soil samples were generally retrieved at 0.75 m intervals by a split spoon sampler in both cohesionless and cohesive soils in accordance with the Standard Penetration Test (ASTM D1586). The SPT carried out with the drilling equipment was performed using a standard 64 kg hammer with a 760 mm drop. Shear vane testing was carried out in cohesive deposits, where encountered, using an MTO vane and ASTM D2573 procedures in order to estimate the undrained shear strength of the cohesive material. Undisturbed samples of the cohesive soils were acquired in thin walled tubes. Bedrock was inferred at numerous locations based on auger refusal and cored using BQ sized equipment in two boreholes.



In addition, twenty-six (26) probe holes, numbered PH1 through PH26, were put down. All of the probeholes were drilled using a 250 mm diameter solid stem augers mounted on a track mounted power line auger drill. Samples from the probe holes, which were drilled to define the locations and depths of a peat deposit, were acquired off the augers.

The subsurface conditions are described in detail in the Borehole Records presented in Appendix 1. All soil samples recovered were identified in the field, stored in moisture proof containers and were returned to our laboratory for detailed classification and testing. Bedrock samples were placed in rock core boxes in the field prior to transportation to the laboratory.

Groundwater levels were recorded in the open boreholes throughout the duration of the investigation and in standpipes installed in select locations. The standpipes were monitored on January 5, 2000. Prior to completing the investigation, the boreholes were backfilled.

Borehole locations were established in the field by Jacques Whitford personnel relative to the established chainage for the Highway 401 median. The ground surface elevations at the borehole locations were referenced to MTO Benchmark 523-70 which is located on the east abutment of the West Bound Structure. It is understood that this benchmark has a Geodetic elevation of 63.571 m. The base plan drawings showing the roadway in plan and profile with metric chainages were provided by MTO.

### **3.2 Laboratory Testing**

All samples returned to the laboratory were subjected to detailed visual classification by a geotechnical engineer. Selected samples were tested for moisture content, Atterberg Limits and grain size distribution as well as consolidation properties. All soil samples will be stored for a period of twelve months after issuance of the final report. Unless otherwise directed, the stored samples will be disposed of after this period.

## **4.0 SUBSURFACE CONDITIONS**

The subsurface conditions observed in the boreholes are presented in detail on the Borehole Records provided in Appendix 1. An explanation of the symbols and terms used to describe the Borehole Records is also provided. A borehole location plan is shown on Drawing 11284-FE1 along with a Stratigraphic plot. Cross-sections are provided on Drawing 11284-FE2.

Within the investigated area between Stations 27+700 and 28+000, Highway 401 is supported on twin eight span structures. The approach fills and apron berms are constructed of granular fills. Peat is generally not present beneath the approach and apron fills but was observed at most other locations. A clay layer was observed beneath the fill and peat, and was in turn underlain by a sand or a sand and gravel layer over bedrock.

A detailed description of the subsurface conditions encountered between Stations 27+700 and 28+000 is given below.

#### **4.1 Silty Sand/Sand (Fill)**

Fill was observed at numerous locations. The approach fills were investigated at BH 99-26 and BH 99-40. At those locations the fill was as thick as 11 m and consisted of materials ranging from silty sand, trace gravel to sand some silt some gravel. The apron fills consisted of similar materials but were of more limited thickness. Rock fill was evident at ground surface around the perimeter of the apron. At some locations the fill extended to elevations below the original grades and was likely placed as backfill for swamp excavation. At other locations, the fill was found directly over organic materials.

Standard Penetration tests in the fill yielded 'N' values ranging from 2 blows/0.3 m to over 100 blows/0.3 m indicating that the fill ranges in density from very loose to very dense. In general the unit can be categorized as compact. The natural moisture content of sixteen samples tested ranged from 5% to 49% with an average of 15%. Two wash sieve, grain-size distribution analyses carried out on representative samples of the fill indicated that it contained 16% to 18% gravel, 42% to 44% sand, and 38 to 42% silt and clay sized particles.

#### **4.2 Organic Deposit**

Dark brown to black fibrous organic peat was encountered at ground surface or below the fill in thirty one of the boreholes. The thickness of this unit, where observed, varied from as little as 100 mm in BH 99-22 and 200 mm in BH 99-26 to over 3 m in BH 99-30, 99-37 and 99-38. The natural moisture content of the peat layers ranges from 46% to 615% with an average of 138% for the twelve samples tested. The SPT N-values ranged from 0 blows/0.3 m to 9 blows/0.3 m indicating that the peat layers, where sampled, are very loose in relative density.

#### **4.3 Clay**

A native deposit of grey clay was encountered below the above described soil layers in all of the boreholes except BH 99-34 and 99-36. The thickness of the deposit, where observed, was determined to range from 1.5 m at BH 99-38 to 5.6 m in BH 99-25. The clay layer was generally thicker to the west.



The deposit is cohesive in behavior. The natural moisture content of twenty-five samples tested ranged from 42% to 96% with an average of 59%. The moisture content values have been plotted against elevation in Figure 2 in Appendix 1. The SPT N-values ranged from 0 blows/0.3 m to 25 blows/0.3 m. Undrained shear strength, based on insitu vane shear tests ranged from 12 kPa to over 100 kPa with an average of 52 kPa for the fifty-five tests conducted. This deposit generally has a firm to stiff consistency. The sensitivity of the deposits was observed to range from 1 to 8.8 with an average of 3.6 which would indicate a low to medium sensitive clay.

The results of Atterberg Limits testing carried out on nine representative samples of this deposit indicated a liquid limit ( $w_L$ ) ranging from 59% to 91% with an average of 68% and a plastic limit ( $w_P$ ) between 20% and 28% with an average of 24% (see the Plasticity Chart on Figure 1 in Appendix 1). The clay deposit at the site can therefore be classified as being of high plasticity (CH).

Consolidation testing was carried out on two undisturbed samples of the clay. The results are plotted in Figures 3 through 6 in Appendix 1. Sample 5 from BH 99-8, which had a liquid limit of 62% has a preconsolidation pressure of 60 kPa, a compression index of 0.56 and a recompression index of 0.05. Sample 5 from BH 99-17, which had a liquid limit of 91% has a preconsolidation pressure of 80 kPa, a compression index of 2.49 and a recompression index of 0.06. The unit weight of these two samples was found to be 1571 kg/m<sup>3</sup> and 1434 kg/m<sup>3</sup> respectively. The existing effective overburden pressure for Sample 5 from BH 99-8 and Sample 5 from BH 99-17 is estimated to be 18 kPa and 14 kPa respectively.

#### **4.4 Silty Sand, and Sand and Gravel (Till)**

Underlying the above noted soils, was a granular material ranging from a silty sand to a sand and gravel some silt, likely of glacial origin. This granular till where fully penetrated, ranged from not observed at BH 99-25 and BH 99-30 to over 6 m at BH 99-38. The elevation of the top of the till ranged from approximately 52 m in the eastern most boreholes to 48 m in the western most boreholes.

The SPT tests carried out in this deposit yielded N-values from 9 blows/0.3 m to over 50 blows/0.3 m, indicating that the deposit ranges in denseness from compact to very dense. In general, the deposit can be categorized as compact. The natural moisture content of fifteen samples ranged from 8% to 64% with an average of 14%. Two wash sieve, grain-size distribution analyses on representative samples of this deposit indicated that it contained 6% to 34% gravel, 40% to 81% sand, and 13 to 26% silt and clay sized particles.

## 4.5 Bedrock

Bedrock was inferred by auger refusal in seventeen of the boreholes and proven by coring in two, at elevations ranging from 46.1 m at BH 99-38 to 49.3 at BH 99-8.

Bedrock was cored in BH 99-3 and 99-13. RQD values ranged from 21% to 93% for the five core runs. The bedrock was observed to be grey, fine grained limestone with occasional shaley layers. The recovered cores indicated near horizontal bedding with layers ranging from 3 mm to over 300 mm in thickness. Jointing was minimal and horizontal along bedding planes, where present. The three samples tested for unconfined compressive strength yielded values of 73 MPa, 79 MPa and 98 MPa.

Borehole Location	Borehole	Inferred Bedrock Elevation (m)
27-862 CL	99-1	48.7
27+869 20 LT CL	99-3	48.9 cored
27+870 71 LT CL	99-8	49.3
27+868 87 LT CL	99-10	49.0
27+863 20 RT CL	99-13	48.0 cored
27+860 62 RT CL	99-17	48.7
27+830 CL	99-23	47.2
27+811 CL	99-24	46.4
27+800 CL	99-25	47.8
27+764 65 LT CL	99-27	47.7
27+804 54 RT CL	99-28	48.6
27+766 63 RT CL	99-29	49.0
27+787 60 LT CL	99-30	48.2
27+890 CL	99-33	49.0
27+910 CL	99-34	48.5
27+925 CL	99-35	48.1
27+942 35 RT CL	99-36	49.1
27+921 33 RT CL	99-37	48.5
27+951 67 LT CL	99-38	46.1



## 4.6 Groundwater

Eleven standpipes were installed during the drilling in December 1999. Groundwater levels were measured on January 5, 2000. At that time the groundwater level was found to range from an elevation of 54.7 m at BH 99-1 to elevation 57.5 m at BH 99-35. The groundwater depth below ground surface was found to range from 0.1 m to 2.2 m on January 5, 2000.

Very wet conditions were noted in BH 99-3 during drilling at a depth of 6.5 m. Sand was observed to rise in the augers at a depth of 6.4 m in BH 99-17.

Fluctuations in the groundwater level due to seasonal variations or in response to a particular precipitation event should be anticipated.

## 5.0 CLOSURE

A subsurface investigation is a limited sampling of a site. The subsurface conditions provided herein are based on information gathered at specific borehole locations and can only be extrapolated to an undefined limited area around these locations. The extent of the limited area depends on the soil and groundwater conditions as well as the history of the site reflecting natural, construction and other activities. Should any conditions at the site be encountered which differ from those at the borehole locations, we request that we be notified immediately in order to assess the additional information.

Yours very truly,

**JACQUES, WHITFORD AND ASSOCIATES LIMITED**



Fred J. Griffiths, Ph.D., P.Eng.



J.G.A. Raymond Haché, M.Sc., P.Eng







# FOUNDATION DESIGN REPORT

For

**Fill Embankment in Settlement Area**

**Cornwall, Ontario**

**W.P. 82-91-00**

**Highway 401/CPR Overhead Structure Removal**

**District 41, Kingston**

## 6.0 PROPOSED DEVELOPMENT

The initial foundation investigation for the twin structures at the subject site was carried out in 1957/58 by E.M. Peto Associates. That investigation identified the presence of peat and soft clay overlying glacial till and bedrock. Additional investigation work was carried out in 1959 by H.Q. Golder and the National Research Council (NRC) to resolve an embankment instability which occurred during construction. A revised embankment design which incorporated twin, 8 span, pile supported structures and stabilizing berms was constructed. The foundations for the structures are supported on H-piles (250 x 62) driven to bedrock.

It is understood that the existing twin eight span structures at the Highway 401/CPR Overhead site require significant structural rehabilitation. As the railway line is now abandoned, the Ministry of Transportation of Ontario (MTO) would like to replace the existing structure with a conventional roadway constructed on an embankment. A culvert would be required in order to maintain drainage from the north to the south. Although the horizontal alignment is not to be modified within the study area, it is proposed to lower the vertical alignment.

There are several constraints to the project which must be considered, as follows:

- At least two lanes of traffic must be maintained at all times.
- The duration of two lane- two way traffic must be minimized.
- Traffic detours outside the existing right-of-way are to be avoided.
- Telephone service through the existing fiber optic line on the south side of the highway must be maintained.
- Work in the area surrounding the site will have restrictions placed on it for environmental reasons.
- Drainage across the site from south to north must be maintained throughout construction.
- The permanent drainage culvert is to be a 1.2 m by 1.2 m open box concrete culvert.
- A permanent electrical duct bank is to be installed crossing the roadway near the existing abandoned railway.

## 7.0 PEAT REMOVAL

A deposit of peat was observed beneath the proposed embankment in numerous boreholes. The peat is an unsuitable material to support a freeway, therefore, all of the peat beneath the footprint of the embankment must be removed and replaced prior to construction of the embankment. It is noted that this will require the removal of overlying fill materials at some locations. Peat removal was generally carried out as part of the original embankment construction, therefore, peat excavation will be limited to the areas between Stations 27+830 and 27+880. The toes of the existing 2:1 embankment slopes will not be undermined.

Although it is likely that peat was removed from beneath and immediately adjacent to the pile cap areas during the initial construction, this has not been confirmed as part of the present investigation. Therefore, if excavation is required beneath the pile caps, care will be required to avoid creating an unbalance of forces adjacent to these founding units. Should excavation beneath pile caps be required, the contractor should submit his proposed method and staging for review by geotechnical engineers, and a geotechnical engineer should be on site to inspect the works and to confirm that it is successfully carried out.

Bottom heave is a significant risk given the soil stratigraphy encountered at this site. Peat removal and replacement should be carried out without dewatering the excavation.

## 8.0 EMBANKMENT OPTIONS

Three finished grade options have been considered. An embankment with a maximum height of 6.5 m is required if the finished grade is at elevation 62.0 m Geodetic. Finished grades of 60.0 m and 58.0 m have also been examined (i.e. embankment heights of 4.5 m and 2.5 m).



## 8.1 Conventional Embankment

### Settlement

Settlement calculations have been carried out based on parameters defined from the investigation and using consolidation theory. The 3.9 m thick clay layer was subdivided into four sub-layers. Given the limited thickness and shallow nature of the compressible layer, the full stress due to peat replacement and embankment loading was used in the calculations to develop the settlement profile for the west bound lanes shown in Figure 7 in Appendix 3. A similar profile is anticipated for the east bound lanes. A Boussinesq stress distribution was utilized to develop the settlement cross section for a finished grade of 60.0 m presented in Figure 8.

It is estimated that primary consolidation of the clay layer would be as much as 650 mm under the embankment loading with a finished grade of 62.0 m Geodetic. Secondary compression is estimated to be a further 100 mm for the period between 6 months and 20 years after construction. Similar calculations have been carried out for other embankment heights. It is noted that the footprint of the embankment and thus the negatively affected areas become smaller with a lower embankment height. The results are as follows:

Finished Grade, Geodetic Elevation	Embankment Height	Primary Consolidation	Secondary Compression
62 m	6.5 m	650 mm	100 mm
60 m	4.5 m	400 mm	100 mm
58 m	2.5 m	120 mm	100 mm

It is estimated that 95% of primary consolidation would occur within 10 months based on a coefficient of consolidation,  $C_v$ , of  $10 \text{ mm}^2/\text{minute}$  and a doubly drained layer 3.9 m in thickness. Settlement time curves are presented in Appendix 3 (Figure 9).

## Stability

Another fundamental concern for the embankment is stability, both during construction and in the long term. Slope stability analyses have been carried out using the GSLOPE software and Bishop's Modified Method assuming that the final road elevation will be at elevation 60.0 m. The following geotechnical parameters were used in the stability analysis:

Soil Type	Unit Weight	Short Term		Long Term	
		Undrained Shear Strength	Friction	Cohesion	Friction
Fill	20 kN/m <sup>3</sup>	-	30°	-	30°
Clay	16.3 kN/m <sup>3</sup>	40 kPa	-	-	27°
Peat	12.6 kN/m <sup>3</sup>	-	27°	-	27°
Sand and Gravel	20 kN/m <sup>3</sup>	-	32°	-	32°
Peat Replacement Material	18 kN/m <sup>3</sup>	-	40°	-	40°

A peak horizontal ground acceleration of 0.18 which corresponds to the recommended level for Montreal with a 10% probability of occurrence in 50 years was used along with short term parameters to assess the impact of an earthquake.

The results of the analyses are as follows:

### FACTOR OF SAFETY

		Results	
Case	Target	2:1 Side Slope	4:1 Side Slope
1. Long Term	1.3	1.45	1.7
2. Short Term	1.3	2.0	2.0+
3. Seismic	1.1	1.17	1.19

The Factor of Safety for each case is in excess of the Target Value. It is noted that the analyses have not accounted for the generation of excess pore pressures in the silty clay layer. However, it can be concluded that a 2:1 side slope is acceptable for the embankment provided excess pore pressure generation is controlled through construction staging or wick drain installation.

Examination of the case where removal of peat is occurring for the West Bound Lanes with an excavation open to elevation 53.0 m is adjacent to the fully constructed East Bound Lane embankment at elevation 62.0 m indicates a Factor of Safety of only 1.1. The results of this analysis suggest that the peat removal and replacement should be carried out beneath both structures prior to constructing the East Bound lane embankment.

### Pore Pressures

The replacement of the peat with heavier fill and embankment construction will increase the stresses within the underlying compressible soils. Stress paths have been plotted in  $p$ - $q$  space based on a  $\phi$  of  $27^\circ$  and a  $K_o$  value of 0.58 in order to assess temporary pore pressure development. The stress path associated within construction of the embankment indicates that the plotted effective stress will cross the failure line, rendering the soil susceptible to failure if non-isotropic loading conditions occur. Typically, this would occur beneath embankment fills with relatively steep slopes or where excavations are carried out. At this site, where placement of embankment fill prior to removal of the bridge is being considered, the existing battered piles will undergo deflection as a result of clay consolidation and will impose loading on the soils perpendicular to the pile axis. Therefore, it is recommended that embankment staging be carried out to maintain the stress path below the failure line.

To maintain the stress path below the failure line, without the use of wick drains or other similar techniques, construction would need to be carried out in stages with delays required to allow for the dissipation of excess pore pressure. The actual stage heights and delay periods would need to be determined during construction on the basis of piezometric and settlement monitoring.

The staging design is based on a  $c_v$  value derived from the consolidation testing carried out for this project (10 mm<sup>2</sup>/minute) and includes delays only long enough to allow approximately 40% of excess pore pressure dissipation. Staging design also considers the dissipation of excess pore pressures during construction. The results of that analysis indicated that a conventional embankment constructed to El 60.0 m would require four stages for construction and a construction/delay period of 56 weeks.

It is noted that a less conservative  $c_v$  value could be employed in the analysis at low stress increments. This could reduce the number of stages to perhaps three for an embankment constructed to El. 60.0 and could also reduce the anticipated construction delay period by 5 to 7 weeks. Nonetheless, the conclusions that for a conventional embankment (without wick drains) constructed to El. 60, a staged construction technique will be required and that the construction delay period will be lengthy are unlikely to change.

Stage	Finished Grade at 62.0		Finished Grade at 60.0		Finished Grade at 58.0	
	Elevation	Constr/Delay Period	Elevation	Constr/Delay Period	Elevation	Constr/Delay Period
1	56.3	5/5 weeks	56.3	5/5 weeks	56.3	5/5 weeks
2	57.3	2/5 weeks	57.3	2/5 weeks	57.3	2/5 weeks
3	58.5	2/5 weeks	58.5	2/5 weeks	58	2/15 weeks
4	60	2/5 weeks	60	2/30 weeks		
5	62	2/36 weeks				
<b>Total</b>		69 weeks		56 weeks		34 weeks

## 8.2 Light Weight Fill Embankment

The use of light weight fill has been examined for this project. Air cooled blast furnace slag has an in place unit weight typically of  $11.0 \text{ kN/m}^3$  (MTO Type 2 light weight fill). A similar analysis has been conducted as described above for the conventional embankment. It has been assumed that the peat removal as described above would still be required and that the light weight fill would require at least 1.5 m of granular fill above it in order to provide adequate support to traffic.

It is estimated that the primary settlement under an embankment constructed to elevation 62.0 m with slag fill would be 450 mm. Similarly, primary settlement for embankment elevations of 60.0 m and 58.0 m with slag fill are estimated to be 310 mm and 140 mm respectively. Settlement time curves are presented in Appendix 3 (Figure 10). The generation of excess pore pressures has also been considered for this option. For an embankment constructed to elevation 60.0 m; three stages of construction would be required, with a delay period of 5 weeks after stages 1 and 2, and a final delay period of 25 weeks.

Polystyrene can also be used as a light weight fill material, however, its placement would be restricted to above the peat and water table. It typically has a unit weight of approximately  $0.5 \text{ kN/m}^3$ . A similar analysis has been conducted as described above for the conventional embankment. It has been assumed that the peat removal as described above would still be required and that the light weight fill would require at least 1.5 m of granular fill above it in order to provide adequate support to traffic.

It is estimated that the primary settlement under an embankment constructed to elevation 62.0 m with polystyrene fill would be 75 mm. Slightly less settlement would be expected for embankment constructed to elevation 60.0 and 58.0 m with polystyrene fill. A settlement time curve is presented as Figure 11 in Appendix 3. The generation of excess pore pressures has also been considered for this option for an embankment with a finished grade of elevation 60.0 m. The embankment could be constructed to the subgrade line in one stage using polystyrene fill.

### **8.3 Wick Drains**

The delays described above for the dissipation of excess pore pressure could be greatly reduced with the installation of wick drains. The wicks should be installed to penetrate into the glacial till at a nominal elevation of 49.0 m. A granular blanket is not considered necessary owing to the planned presence of highly permeable fill replacing the peat and the presence of granular fill elsewhere. Thus it is likely that the excess pore pressures generated would drain sufficiently quickly that the entire embankment could be constructed in one stage to elevations 58, 60 or 62.

### **8.4 Removal of Clay Layer**

The majority of the total settlement and all of the long term settlement and stability concerns are associated with the presence of the clay layer. The clay could be excavated and removed entirely. This layer extends only to an elevation of approximately 48 m, a worst case depth of approximately 10 m. The depth would be dependant on final embankment heights. The lower the embankment height the more limited the excavation area. The critical stage of the work is during excavation of the clay for the east bound lanes adjacent to the west abutment of the west bound lanes. Total stress analysis of the excavation indicates a Factor of Safety against slope failure of 1.26 is available during this critical excavation stage provided excavation side slopes are no steeper than 3 horizontal to 1 vertical. There is insufficient room to achieve this excavation slope, therefore, a temporary detour away from the work would be necessary or the excavation would need to be shored.

A second consideration with regard to full depth removal of the clay layer is the requirement to shore the bridge deck if this work is to be carried out while traffic is maintained, since this activity could result in up to 4.0 m of temporary unsupported pile length. Considering that the piles are relatively short and the quality of the concrete/steel pile interface is unknown, it is not recommended that full depth removal of the clay be carried out without shoring to support the deck while traffic is maintained.

## 8.5 Embankment Construction Prior to Structure Removal

It has been proposed to construct the embankments for Highway 401 to Elevation 60 in advance of the removal of the existing structures. Harmer Podolak Engineering Consultants Limited (H&P), the structural engineer for the assignment, have indicated that the existing structures are supported on H-piles (250x62) and that the design load per pile was 35 tons (310 kN), and that the majority of the piles within each pile cap are battered at 4H:1V. We have reviewed the General Arrangement Drawing for the structures and generated the following table of approximate locations and elevations for the foundations. It has been assumed that the Pile Caps are 0.9 m thick and 1.98 m wide.

Pier	East Bound Lanes		West Bound Lanes	
	Station	Elevation of Underside of Pile Cap	Station	Elevation of Underside of Pile Cap
A	27+787	57.4	27+811	57.5
B	27+806	57.1	27+829	57
C	27+825	56.5	27+848	53.9
D	27+844	53.9	27+867	53.9
E	27+862	53.9	27+886	53.9
F	27+881	55.8	27+905	56.7
G	27+900	57.1	27+924	57.5

The following geotechnical issues have been identified as being critical to the success of this concept.

### 8.5.1 Peat Removal

For the East Bound Lanes the excavation and replacement of the peat will occur on both sides of Piers D, E and F. It is anticipated that the peat immediately beneath the pile caps has already been removed. Thus the proposed excavation will result in a nearly-unsupported pile length of approximately 0.9 m for Piers D and E, and a nearly-unsupported pile length of 2.8 m for Pier F. The risk of pile buckling should be assessed using the following table of soil parameters to assess soils resistance for Pier F of the East Bound Lanes.



Elevation Interval	Soil Type	Submerged Unit Weight	Angle of Internal Friction	Undrained Shear Strength	Constant of Horizontal Subgrade Reaction, $n_h$
53.0 - 51.3	Clay	5.0 kN/m <sup>3</sup>		40 kPa	10 MPa/m
51.3 - 49.0	Sand	10.2 kN/m <sup>3</sup>	32°		4.5 MPa/m
49.0 and lower	Bedrock				-

The horizontal modulus of subgrade reaction,  $k_h$ , can be calculated by multiplying the constant of horizontal subgrade reaction,  $n_h$ , by depth.

The excavation and backfilling will need to be carried out such that unbalanced forces are not present from side to side. It is anticipated that peat removal will be required on one side only for Pier C of the East Bound Lanes. Nonetheless, excavation and backfilling should be carried out on both sides to avoid unbalanced forces.

Similar conditions are expected for the West Bound Piers C, D, E and F. The proposed excavation will result in a nearly-unsupported pile length of approximately 0.9 m for Piers C, D and E. It is anticipated that peat removal will be required on one side only for Pier F of the West Bound Lanes. Nonetheless, excavation and backfilling should be carried out on both sides to avoid unbalanced faces.

### 8.5.2 Foundation Response to Embankment Construction Beneath the Bridges

The primary foundation responses that must be addressed as part of this method of construction are as follows:

- Settlement induced loading on the piles and pile caps
- Deformation of the battered piles. Typically battered piles deflect with the strain occurring within the consolidating soil. These piles typically go in tension, inducing additional axial loads on the vertical piles, and depending on the state of the steel pile/concrete interface it can pull the batter piles out of the pile caps.
- Differential settlements can occur across the width of the embankment as well as along the profile. These settlements could result in horizontal movements within the soil mass, subjecting the columns between the pile caps and the bridge deck to horizontal forces. Therefore, this option would require extensive monitoring and contingency planning to accommodate horizontal movements of the columns.

### Settlement Induced Loading

The proposed construction of the embankment prior to demolition of the structure will impose additional loads on the piled foundations. Settlement will be induced in the compressible soils at this site due to the weight of the embankment. The piles, which are end bearing on bedrock, will not settle, thus there will be downdrag forces as the soils settle around the piles. The values provided below have been estimated assuming a vertical HP 250x62 pile and the  $\beta$  method of downdrag calculation.

In addition, there will be embankment material placed directly on the pile cap, thus the pile caps will be subject to the weight of the soil over them as well. The values provided below have been estimated assuming a 1.98 m wide pile cap and using a conservative stress distribution with a unit weight of 20 kN/m<sup>3</sup>.

There may also be downdrag forces acting on the pier columns. These forces have been accounted for in the conservative estimates of force from the overlying fill on the pile cap.

The following table summarizes the estimates of the additional forces for the West and East Bound Lanes. It is noted that the force from the overlying fill listed in the table below is conservative as a portion of the volume above the pile cap is and will be occupied by the existing concrete columns. The dead load of the structure includes the column weight, therefore the weight of an equivalent volume of soil could be removed from the values in the table.

Pier	WEST BOUND		EAST BOUND	
	Downdrag Force, kN per pile	Force from Overlying Fill on Pile Cap, kN/m length	Downdrag Force, kN per pile	Force from Overlying Fill on Pile Cap, kN/m length
A	335	12	335	20
B	500	52	500	45
C	200	502	405	100
D	140	502	140	502
E	130	502	130	502
F	350	80	290	185
G	470	12	450	45



The downdrag forces provided above are unfactored and can be considered as SLS values. The factors listed in Table 2-5.1(b) of the OHBDC should be applied as required by the structural engineer to obtain the load at ULS. Some variation in the downdrag loads at each pile cap should be anticipated. The values provided above, which have been generated with conservative assumptions, should be viewed as the maximum downdrag force per pile at each pile cap. The minimum may be 20% lower than the value provided.

The impact of these additional loads should be evaluated using the capacity of the pile compared to the permanent load plus the drag load; live load not included. The dead load must be adjusted to account for the loads generated by the embankment fill placed on the pile caps. Both the geotechnical and structural pile capacities need to be checked.

A Factored Geotechnical Resistance for Axial Loads at ULS of 950 kN per pile can be utilized for HP250x62 piles bearing on the limestone at this site based on a cross-sectional area of 7980 mm<sup>2</sup> for the 250x62 H piles. Utilizing a factored geotechnical resistance of 100 MPa in accordance with the OHBDC 6-9.7.8, a factored geotechnical resistance of 800 kN per pile is indicated. A less conservative value of 120 MPa was used in our analysis which is based in part on a working stress value of 80 MPa multiplied by 1.5 to bring it to an equivalent ULS design value. The geotechnical resistance at SLS is estimated to be 650 kN.

It is understood from the Structural Engineer that based on the above recommended values the factored loads exceed the geotechnical factored resistance of the piles at West Bound Piers C, D and E and East Bound Piers D and E. A reduction in the vertical force acting on the pile cap can be achieved by utilizing polystyrene fill over the pile cap in place of conventional embankment fill. A 3.35 m high lift of polystyrene placed full width and full length across the pile cap would reduce the vertical forces on the pile cap provided in the table above by 130 kN/m length.

### Deformation of Battered Piles

It is also noted that battered piles do not perform as well as vertical piles when subject to downdrag loads. Piles that are inclined will be forced to bend by the settling soil. The structural impacts generated on battered piles can be assessed using the following table of deflections for Pier D of the West Bound Lanes assuming the embankment is constructed of earth borrow, select subgrade material or rockfill:

Elevation	Vertical Deflection
53.3 m	435 mm
52.4 m	373 mm
51.4 m	229 mm
50.4 m	75 mm
49.4 m	5 mm
48.7 m	0 mm

Batter piles subjected to more than 50 mm of settlement should be considered to be in tension and therefore any axial loads that they carry should be transferred to the vertical piles within the group. The deflected batter piles that go into tension will transfer additional downward loads to the pile cap. The maximum downward load which could be transferred to the pile cap would correspond to the vertical component of the pull out capacity of each batter pile. The axial pull out capacity of the batter piles are estimated to be half of the down drag forces provided above.

### Differential Settlements

Lateral forces in the structure will also develop in response to differential settlement from the underlying soils. The settlement profiles of Figures 7 and 8 in Appendix 3 can be utilized to determine the base differential settlements both longitudinally and transversely to the structures. Due to the inherent variability of soils, it is recommended that the base differential movements be doubled during the analysis.

### 8.5.3 Structure Removal

The possibility of the presence of buried piers and abutments causing bumps in the finished pavement has been addressed. It is expected that the ground around the existing foundations will not settle relative to the remainder of the fill. Substantial secondary compression is predicted (100 mm), beyond the anticipated primary consolidation of approximately 400 mm. Construction of the embankment in advance of the structure removal complicates the timing of the settlement due to the presence of the pile caps. Figure 12 in Appendix 3 provides predicted differential settlement versus time curves. The curves have been generated by subtracting the amount of settlement at pile cap D of the west bound lanes from a location mid way between pile caps C and D. Two scenarios are envisioned.

The first considers differential settlement with the *pile cap removed* and the roadway paved approximately 32 weeks after initial completion of the embankment. Thus, there is 0 mm differential movement between the former pile cap and midway between pile caps at Week 32. Beyond Week 32, there will be more settlement at the pile cap location (primary and secondary) than midway between pile caps. This differential movement will be rapid at first then slow over time.

The second scenario, would leave the *pile cap in place*, this would result in very little movement at the pile cap beyond Week 32, while movements occurred at the mid point between pile caps.

It is noted that by Week 1000 (19 years) after completion of the embankment, the differential movements are nearly of the same magnitude, however, leaving the pile caps in place results in a bump at the pile caps, while taking them out, results in a dip at the pile cap locations. Given the more rapid development of differential movements associated with removing the pile caps, it is recommended that they be left in place. However, it is predicted that 50 mm high bumps could be generated within 2 to 5 years. Each bump will cover an area equal to the width of the pile cap and taper out over a distance equal to the thickness of the fill overlying the pile cap.

It is noted that surcharging will have only a limited impact on the above effects. The predicted differential movements are the result of secondary compression as opposed to primary consolidation. Surcharging would eliminate the earliest portion of the secondary compression however, the long term effects would be very similar. Furthermore, surcharging would adversely affect the development of pore water pressures during construction which could have stability implications.

## 8.5.4 Monitoring Requirements

It is noted that embankment construction prior to structure removal has significant unknowns relating to the condition of the existing pile cap and piles, and can relate to the rate of settlement. Of all geotechnical challenges, predicting the rate of settlement accurately is one of the most difficult. At this site, differential rates of settlement, possibly due to discontinuous sand seams, could result in differential backfill earth pressure loading on some of the structural elements. Therefore, monitoring of the structure during and after embankment construction will be required.

## 9.0 DISCUSSIONS

Based on the analyses carried out to date the following can be concluded:

- The peat must be removed from beneath the embankment footprints and replaced with fill to the existing ground level within both the west bound and east bound lanes.
- Conventional embankment construction is not possible at this site without a staged construction approached.
- Lowering the finished grade of the roadway would reduce the number of stages required.
- Use of light weight fill would reduce the number of stages required.
- Removal of the clay material would require shoring or a substantial detour.
- Wick drains could be utilized to accelerate drainage of excess pore pressure.
- The footprint of the problem area becomes smaller with a decrease in final embankment grade.



The following table provides a crude approximation of the embankment costs for the various options described above.

OPTION	ELEVATION	COST	Advantages	Disadvantages
Conventional Embankment	62	\$490,000		<ul style="list-style-type: none"> <li>- very long construction schedule</li> <li>- greatest risk of ongoing settlement problems</li> </ul>
	60	\$330,000		
	58	\$300,000		
Slag Fill Embankment	62	\$2,050,000		<ul style="list-style-type: none"> <li>- long construction schedule</li> <li>- re-use of material from existing approaches reduced, increases disposal costs</li> </ul>
	60	\$1,160,000		
	58	\$ 380,000		
Polystyrene Fill Embankment	62	\$3,200,000	<ul style="list-style-type: none"> <li>- low risk of ongoing settlement problems</li> <li>- short construction schedule</li> </ul>	<ul style="list-style-type: none"> <li>- re-use of material from existing approaches reduced, increases disposal costs</li> </ul>
	60	\$1,700,000		
	58	\$ 415,000		
Clay Removal	62	\$920,000	<ul style="list-style-type: none"> <li>- eliminates settlement problem</li> </ul>	<ul style="list-style-type: none"> <li>- difficult shoring required</li> <li>- dewatering difficulties or need for rock fill</li> <li>- larger environmental concerns</li> <li>- impact to fibre optic line</li> </ul>
	60	\$715,000		
	58	\$640,000		
Wick Drains	62	\$615,000	<ul style="list-style-type: none"> <li>- short construction schedule</li> </ul>	
	60	\$435,000		
	58	\$390,000		

It is recommended that the finished grade be set at elevation 60.0 m. This will decrease the embankment footprint and hence the area of concern. It also permits the option of constructing the embankment prior to structure demolition to be carried forward. Lowering the grade below 60.0 will result in cost increases due to significant increases in material disposal and would result in a poorer transition to the existing roadway particularly on the east side.

It is also recommended that wick drains be utilized to accelerate the construction schedule. The decision to construct the embankments in advance of structure removal should be based on a review of the costs, construction durations and the risks associated with these two options.

## 10.0 RECOMMENDATIONS

### 10.1 Culvert Construction

#### 10.1.1 Design Considerations

The existing drainage culverts are to be replaced with a 1.2 m by 1.2 m open footing box culverts as follows:

Size:	1200 mm x 1200 mm concrete culvert with open footings
Length:	approx. 94 m
Flow:	Direction - South to North
Invert Elevation:	54.6 m

It is anticipated that the culvert will be constructed in accordance with MTO Standard Drawing SS114-1.

A grade raise of approximately 4.5 m is proposed to reach the pavement elevation of 60.0 m. The embankment geometry is as follows:

Culvert Location	Height of Fill Over Culvert (m)	Height of Fill Over Culvert Invert (m)	Sideslopes
27+895	3.7	5.4	2H:1V

The proposed grade raise will result in increased stresses in the soil beneath the proposed culvert. It is estimated that settlement in the order of 350 to 420 mm would occur at the culvert location should the embankment over the culvert be constructed with conventional fill material. Polystyrene fill is recommended.

#### 10.1.2 Foundation Recommendations

The existing peat material is to be removed and replaced as per the recommendations provided in Section 10.2 below.

The undersides of the foundations should be provided with a frost cover equivalent to 1.6 m. Adequate frost protection can be achieved provided the footings are as shown in Drawing 11284-FE5 in Appendix 4. The footings should be set at elevation 54.0 m and placed on at least 1.0 m of non-frost susceptible peat replacement material placed directly on the non-organic clay soil.





The following design parameters may be used for box culverts founded on at least 1000 mm of peat replacement material placed directly on the native non-organic clay soil.

Founding Elevation (m)	approx. 54.0 m
Factored Geotechnical Resistance at ULS	180 kPa
Geotechnical Resistance at SLS	100 kPa

It is noted that the Geotechnical Resistance at SLS has been calculated such that the settlement induced due to the foundation load will be less than 25 mm. The embankment should be constructed as per Drawing 11284-FE5 in Appendix 4.

Sliding resistance between the concrete and the peat replacement material should be calculated in accordance with Section 6-8.4.3 of the OHBDC using an unfactored friction coefficient of 0.55.

Sliding resistance between polystyrene blocks or between polystyrene blocks and granular soil should be estimated using an unfactored friction coefficient of 0.50.

Provided that the polystyrene fill is incorporated in the design, the structural design of the culvert may be based on an equivalent fill height of 1.6 m.

### 10.1.3 Lateral Earth Pressures

The walls of the culvert may be considered as a fully restrained surface and lateral earth pressures corresponding to the at-rest condition should be used for design. The unfactored soil parameters presented in the table below may be used for design.

Parameter	OPSS Granular A	Polystyrene Fill	Earth Borrow
Bulk Unit Weight, $\gamma$ (kN/m <sup>3</sup> )	22.5	0.5	20.5
Effective Friction Angle, $\phi$	35°	30°	27°
At-rest Earth Pressure Coefficient, $K_o$ (horizontal backslope)	0.43	0.5	.55

The properties of the granular fill should be used to determine the lateral earth pressure. The earth pressure should have a triangular distribution with the apex at the ground surface.

The effects of compaction should be accounted for by applying a compaction surcharge as shown in Figure 6-7.4.3 of the OHBDC 3<sup>rd</sup> Edition.

#### **10.1.4 Construction Recommendations**

##### ***Site Grading and Preparation***

The peat replacement material beneath the footings should be compacted with vibratory equipment. Any loose or soft material should be removed from beneath the footings.

Stripping of deleterious materials should be inspected by geotechnical personnel to ensure that all unsuitable materials are removed prior to concrete placement. Structural fill, where required, should consist of OPSS Granular A or Granular B, Type II, placed in lifts no greater than 300 mm thick and compacted to at least 98 % standard Proctor maximum dry density.

##### ***Excavation and Backfill***

Excavation and backfill for the culvert should conform to OPSD-803.01 or OPSD-803.02 and Drawing 11284-FE5 in Appendix 4. Within a lateral distance of 600 mm on each side of the culvert, granular backfill such as OPSS Granular A material should be used to avoid high stress points on the culvert. This material should be placed in lifts no greater than 300 mm thick and compacted to at least 95 % SPMDD.

The material used to backfill the interior of the culvert above the footings should be OPSS Granular A material in order to provide adequate lateral support and vertical embedment to the footings. It is understood that fish utilization of the culvert will be restricted to within 2 m of either end. At those locations, a 150 mm lift of peat could be placed above a reduced thickness of the OPSS Granular A in order to provide the desired peat substrate identified by Fisheries and Oceans Canada. It is noted that peat when disturbed and then placed as a construction material does not provide significant erosion protection. The peat layer should be inspected annually. Maintenance of the peat layer should be anticipated.

Side slopes for open cut excavations should conform to the Occupational Health and Safety Act and Regulations for Construction Projects. It is anticipated that the peat replacement work will have been completed prior to culvert construction. The soils encountered in the proximity of the culvert will therefore be Peat Replacement Material which is a Type 3 soil. In general, temporary excavations within a Type 3 soil should be made with slopes no steeper than one horizontal to one vertical from the base of the excavation.



A depth of frost treatment,  $f$ , of 1.5 m should be used at this site.

The embankment should be constructed as indicated on Drawing 11284-FE-5 in Appendix 4. A thin layer of sand should be placed as a levelling course over the peat replacement material and OPSS Granular A. The supply and construction of the polystyrene fill should be as per the Special Provision provided in Appendix 5. The sideslope of the polystyrene fill should be no steeper than 2H:1V. A minimum soil cover of 250 mm is required on side slopes.

### ***Dewatering and Protection of Founding Level***

The proposed founding elevation for the culvert is below the water table observed at the time of the investigation. Dewatering will likely be required during construction. The use of sump pumps and coffer dams may be used during construction of the culvert. Significant volumes of inflow should be anticipated due to the high permeability of the peat replacement material.

### ***Erosion Protection & Sediment Control***

Erosion protection should be provided at the inlet and outlet ends of the proposed culvert. Erosion protection can be achieved by placing a Class 2 non-woven geotextile on the graded ground surface and covering with a 300 mm thick layer of rip-rap stone. The protected area should extend laterally to at least 1.5 m beyond the culvert, and should extend vertically to 0.5 m above the normal spring flow level. The rip rap protection could be surfaced with a peat material to provide a greener surface appearance, however, it is noted that peat when disturbed and then placed as a construction material does not provide significant erosion protection. The peat layer should be inspected annually. Maintenance of the peat layer should be anticipated. Alternatively, the rip rap treatment surfaced with peat could be replaced with an erosion control blanket such as one of the Curlex Excelsior Blankets manufactured by American Excelsior Company.

The final erosion protection design should be reviewed by the geotechnical engineer.

The contractor should provide silt fences and erosion control blankets, as required, throughout the duration of the construction to prevent silt/sediment leaving the site.

## 10.2 Peat Removal

Peat excavation will be limited to the areas between Stations 27+830 and 27+880 as indicated on Drawing 11284-FE3. This work should be carried out in stages with excavations backfilled prior to proceeding to the next excavation. Increments should be no wider than 5 m. No excavation should be left open for more than 4 hours. Excavation work adjacent to pile caps should be restricted such that an area defined by a 1 horizontal to 1 vertical wedge around all foundation units in use is protected. This corresponds to a buffer of approximately 4 m horizontally around the foundation units. The last wedge of peat around the pile caps should be removed on both sides of the pile cap simultaneously to avoid unbalanced lateral forces. Peat removal and replacement should be carried out without dewatering the excavation. Backfill should consist of clean particles between 13.2 mm and 75 mm in size.

If peat is present within the buffer of 4.0 m around the foundation units, it should be excavated in strips no wider than 2.0 m and the contractors proposed method and equipment should be reviewed and approved by a geotechnical engineer.

The outside limits of peat removal should extend to 30 m from the median centreline. Peat should be completely removed beneath the median.

## 10.3 Excavations

Earth excavation should be carried out in accordance with OPSS-206. Side slopes for open cut excavations should conform to Occupational Health and Safety Act regulations. Above groundwater level temporary cut slopes should be no steeper than 1 horizontal to 1 vertical from the base of the excavation. For excavations below groundwater levels temporary cut slopes should be anticipated to be no steeper than 1.5 horizontal to 1 vertical provided the work is carried out in the wet and workers are not permitted in the excavation. In order to minimize the risk of slope instabilities during construction below the water or ground water level, the width of such excavations at any one time should be restricted to no greater than 5 m. In addition, the duration excavations are left open should be limited to four hours.

Encroachment of excavations into pile cap areas should be carried out as described in Section 10.2.



## 10.4 Site Preparation

Surficial vegetation, rootmat and topsoil should be removed beneath the approach embankments. Stripping of deleterious materials should be inspected by geotechnical personnel to ensure that all unsuitable materials are removed prior to placement of fill. It is noted that existing fill materials may be removed in some locations in order to provide adequate headroom for installation of wick drains. The exposed subgrade surface should be surface compacted using suitable compaction equipment to 95% of Standard Proctor maximum dry density where applicable.

## 10.5 Dewatering

Peat removal and replacement should be carried out in the wet.

Recommendations for dewatering for culvert construction are presented in Section 10.1.4.

## 10.6 Wick Drain Installation

Wick design is based on the Wick Drain Spacing Graph, Figure 8, provided in the Nilex Vertical Drain Technical Design Manual and utilizes the following:

- target was to maintain excess pore pressure to less than 40 kPa throughout construction
- represents a dissipation of approximately 50% at mid point of the clay layer
- construction requires six weeks
- the consolidation coefficient for horizontal flow is roughly twice that for vertical flow

The consolidation test results indicate that the consolidation coefficient for vertical flow,  $c_v$ , ranges between 10 mm<sup>2</sup>/minute and 20 mm<sup>2</sup>/minute (see Figures 4 and 6 in Appendix 1). Wick drain spacing assuming a triangular pattern has been calculated to be as follows:

$c_v = 10 \text{ mm}^2/\text{minute}$	spacing = 1.59 m
$c_v = 12 \text{ mm}^2/\text{minute}$	spacing = 1.77 m
$c_v = 14 \text{ mm}^2/\text{minute}$	spacing = 1.83 m

It is recommended that wick drains should be installed in the area indicated in Drawing 11284-FE4 in Appendix 4. The drains should be installed on a triangular spacing with a spacing of 1.75 m. The wicks should be designed to fully penetrate the clay layer, i.e. to elevation 48.0 m. The supply and installation of the wick drains should be as per the special provision presented in Appendix 5. It is noted that installation of the wicks prior to removal of the structures will be more difficult due to the restriction to head room. Some of the existing fill material may need to be removed to increase headroom.

## 10.7 Embankment Construction

The embankment should be constructed with side slopes no steeper than of 2 horizontal to 1 vertical. Slope flattening would impact the anticipated settlements at this site and is not recommended without additional geotechnical analysis and most likely a wider wick drain installation area.

The embankments should be constructed in accordance with OPSS 206 and 501. It is anticipated that the material excavated from the existing approach fills will be suitable for use as embankment fill. Rock fill, earth borrow and Select Subgrade Material are considered acceptable for embankment construction.

It is noted that there will be a minor amount of internal settlement of the embankment material (less than 25 mm). This settlement will occur very quickly and will likely be complete within a week of completion of the embankment.

As discussed in Section 8.5.2 above, it is recommended that polystyrene fill be placed above the pile caps for West Bound Piers C, D and E, and East Bound Piers D and E. The polystyrene should be placed as indicated in the typical detail Drawing 11284-FE6. Supply and installation of polystyrene fill should be in accordance with the Special Provision provided in Appendix 5. It is recommended that the pier columns be cut off at a point 1.5 m below finished grade.

## 10.8 Duct Work

It is understood that a duct bank will need to be installed beneath the embankment, the abandoned railway line. A steel pipe as large as 450 mm in diameter is proposed with an invert elevation of approximately El 55 m.

The presence of the duct bank should not interfere with the installation of the wick drains as the wicks will be installed prior to the duct bank. Three options have been considered for the installation of the duct bank:

- install the duct bank during embankment construction and design it to settle as per Figure 8 in Appendix 3.
- install the duct bank during embankment construction and place polystyrene fill above it in a similar fashion as that proposed for the culvert.
- install the duct bank utilizing jack and bore techniques sometime after construction of the embankment.



It is understood that the duct bank will not tolerate the amount of settlement anticipated for this embankment, thus the first option is not viable. The duct bank could be placed on the pile caps however unacceptable settlements (300 mm) would occur in the median and beneath the sideslopes. Both the second and third options are technically viable, however, the third option is recommended as it is understood to be more cost effective.

It is noted that the amount of settlement which the duct bank will experience is related to the timing of the installation as indicated in Figure 12. The duct bank should be designed to accommodate at least 50 mm of movement within 2 years of installation and 100 mm of movement over 20 years.

It is recommended that the duct bank be installed midway between piers in order to minimize the effects of differential settlement through the median. A smoother settlement cross-section should be anticipated midway between piers.

Reaction to jacking against the peat replacement fill can be calculated using the following parameters for the peat replacement material:

$\gamma$  = unit weight = 18 m

$K_p$  = coefficient of passive earth pressure = 4.60

$K_a$  = coefficient of active earth pressure = 0.22

## **10.9 Instrumentation**

Geotechnical and structural instrumentation programs are required. The geotechnical instruments are required to monitor the progress of the anticipated settlements and to ensure that excessive pore water pressures do not develop. The structural instruments will monitor the response of the structure to the construction of the embankments.

## **10.10 Erosion Control**

Slope protection and drainage measures will be required to ensure the long-term stability of the embankment slopes. Normal slope vegetation should be established as soon as possible after completion of the embankment in order to control surface erosion.

The contractor should provide silt fences and erosion control blankets, as required, throughout the duration of the construction to prevent silt/sediment from running off the site.

## **10.11 Frost Protection**

Foundations where present should be provided with the equivalent of 1.6 m of earth cover for frost protection.

## 11.0 CLOSURE

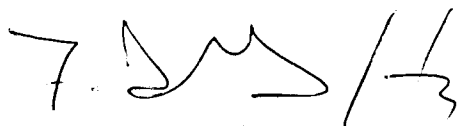
The recommendations made in this report are in accordance with our present understanding of the project. We request that we be permitted to review our recommendations when the drawings and specifications are complete.

A foundation investigation is a limited sampling of a site. The conclusions given herein are based on information gathered at the specific borehole locations and can only be extrapolated to an undefined limited area around these locations. The extent of the limited area depends on the soil and groundwater conditions, as well as the history of the site reflecting natural, construction, and other activities. Should any conditions at the site be encountered which differ from those at the borehole locations, we request that we be notified immediately in order to assess the additional information and its effects on the above conclusions.

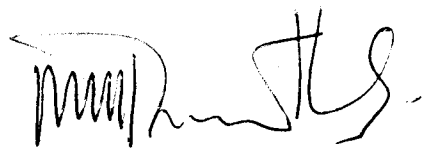
We trust the information presented herein meets your present requirements. Should you have any questions or require additional information, please do not hesitate to contact us.

Yours very truly,

**JACQUES, WHITFORD AND ASSOCIATES LIMITED**



Fred J. Griffiths, Ph.D., P.Eng.



J.G. Raymond Haché, M.Sc., P.Eng.





## **APPENDIX 1**

### **Explanation of Terms Used in Report**

#### **Borehole Records**

#### **Figure 1 (Plasticity Chart)**

#### **Figure 2 (Atterberg Limits and Shear Strengths vs Elevation)**

#### **Figured 3-6 (Consolidation Test Results)**

## SYMBOLS AND TERMS USED ON BOREHOLE AND TEST PIT RECORDS

### SOIL DESCRIPTION

Terminology describing common soil genesis:

<i>Topsoil</i>	-	mixture of soil and humus capable of supporting good vegetative growth
<i>Peat</i>	-	fibrous aggregate of visible and invisible fragments of decayed organic matter
<i>Till</i>	-	unstratified glacial deposit which may range from clay to boulders
<i>Fill</i>	-	any materials below the surface identified as placed by humans (excluding buried services)

Terminology describing soil structure:

<i>Desiccated</i>	-	having visible signs of weathering by oxidization of clay minerals, shrinkage cracks, etc.
<i>Fissured</i>	-	having cracks, and hence a blocky structure
<i>Varved</i>	-	composed of regular alternating layers of silt and clay
<i>Stratified</i>	-	composed of alternating successions of different soil types, e.g. silt and sand
<i>Layer</i>	-	> 75 mm
<i>Seam</i>	-	2 mm to 75 mm
<i>Parting</i>	-	< 2 mm
<i>Well Graded</i>	-	having wide range in grain sizes and substantial amounts of all intermediate particle sizes
<i>Uniformly Graded</i>	-	predominantly of one grain size

Terminology describing soils on the basis of grain size and plasticity is based on the Unified Soil Classification System (USCS) (ASTM D-2488). The classification excludes particles larger than 76 mm (3 inches). This system provides a group symbol (e.g. SM) and group name (e.g. silty sand) for identification.

Terminology describing materials outside the USCS, (e.g. particles larger than 76 mm, visible organic matter, construction debris) is based upon the proportion of these materials present:

<i>Trace, or occasional</i>	Less than 10%
<i>Some</i>	10-20%

The standard terminology to describe cohesionless soils includes the compactness (formerly "relative density"), as determined by laboratory test or by the Standard Penetration Test 'N' - value.

Relative Density	'N' Value	Compactness %
<i>Very Loose</i>	< 4	< 15
<i>Loose</i>	4-10	15-35
<i>Compact</i>	10-30	35-65
<i>Dense</i>	30-50	65-85
<i>Very Dense</i>	> 50	> 85

The standard terminology to describe cohesive soils includes the consistency, which is based on undrained shear strength as measured by insitu vane tests, penetrometer tests, unconfined compression tests, or occasionally by standard penetration tests.

Consistency	Undrained Shear Strength		'N' Value
	kips/sq. ft.	kPa	
<i>Very Soft</i>	<0.25	<12.5	<2
<i>Soft</i>	0.25-0.5	12.5-25	2-4
<i>Firm</i>	0.5-1.0	25-50	4-8
<i>Stiff</i>	1.0-2.0	50-100	8-15
<i>Very Stiff</i>	2.0-4.0	100-200	15-30
<i>Hard</i>	>4.0	>200	>30

## ROCK DESCRIPTION

### Rock Quality Designation (RQD)

The classification is based on a modified core recovery percentage in which all pieces of sound core over 100 mm long are counted as recovery. The smaller pieces are considered to be due to close shearing, jointing, faulting, or weathering in the rock mass and are not counted. RQD was originally intended to be done on NW core; however, it can be used on different core sizes if the bulk of the fractures caused by drilling stresses are easily distinguishable from *in situ* fractures.

#### RQD

#### ROCK QUALITY

90-100	Excellent, intact, very sound
75-90	Good, massive, moderately jointed or sound
50-75	Fair, blocky and seamy, fractured
25-50	Poor, shattered and very seamy or blocky, severely fractured
0-25	Very poor, crushed, very severely fractured

Terminology describing rock mass:

Spacing (mm)	Bedding, Laminations, Bands	Discontinuities
2000-6000	<i>Very Thick</i>	<i>Very Wide</i>
600-2000	<i>Thick</i>	<i>Wide</i>
200-600	<i>Medium</i>	<i>Moderate</i>
60-200	<i>Thin</i>	<i>Close</i>
20-60	<i>Very Thin</i>	<i>Very Close</i>
<20	<i>Laminated</i>	<i>Extremely Close</i>
<6	<i>Thinly Laminated</i>	

Strength Classification	Uniaxial Compressive Strength (MPa)
<i>Very Low</i>	1-25
<i>Low</i>	25-50
<i>Medium</i>	50-100
<i>High</i>	100-200
<i>Very High</i>	>200

Terminology describing weathering:

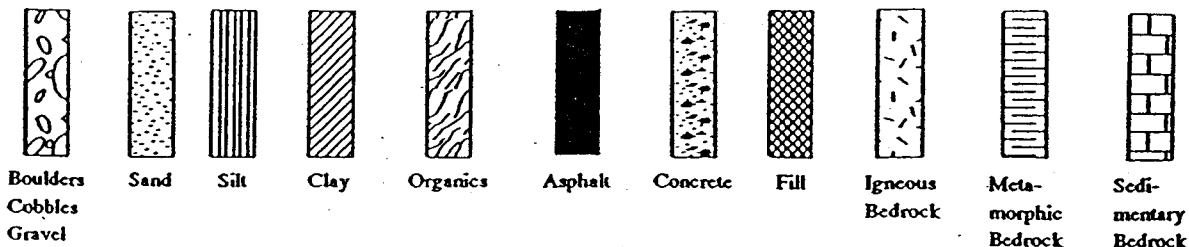
<i>Slight</i>	-	Weathering limited to the surface of major discontinuities. Typically iron stained.
---------------	---	---



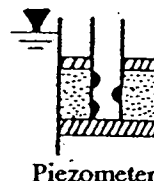
- |          |   |   |
|----------|---|---|
| Moderate | - | Weathering extends throughout rock mass. Rock is not friable. |
| High     | - | Weathering extends throughout rock mass. Rock is friable.     |

## STRATA PLOT

Strata plots symbolize the soil or bedrock description. They are combinations of the following basic symbols:



## WATER LEVEL MEASUREMENT



## SAMPLE TYPE

SS	Split spoon sample (obtained by performing the Standard Penetration Test)	BS	Bulk sample
ST	Shelby tube or thin wall tube	WS	Wash sample
PS	Piston sample	HQ, NQ, BQ, etc.	Rock core samples obtained with the use of standard size diamond drilling bits.

## N - VALUE

Numbers in this column are the results of the Standard Penetration Test: the number of blows of a 140 pound (64 kg) hammer falling 30 inches (760 mm), required to drive a 2 inch (50.8 mm) O.D. split spoon sampler one foot (305 mm) into the soil. For split spoon samples where insufficient penetration was achieved and 'N' values cannot be presented, the number of blows are reported over sampler penetration in millimetres (e.g. 50/75).

## OTHER TESTS

S	Sieve analysis	H	Hydrometer analysis
G <sub>s</sub>	Specific gravity of soil particles	$\gamma$	Unit weight
k	Permeability (cm/sec)	C	Consolidation
	Single packer permeability test; test interval from depth shown to bottom of borehole	CD	Consolidated drained triaxial
	Double packer permeability test; test interval as indicated	CU	Consolidated undrained triaxial with pore pressure measurements
	Falling head permeability test using casing	UU	Unconsolidated undrained triaxial
	Falling head permeability test using well point or piezometer	DS	Direct shear
		Q <sub>u</sub>	Unconfined compression
		I <sub>p</sub>	Point Load Index (I <sub>p</sub> on Borehole Record equals I <sub>p</sub> (50); the index corrected to a reference diameter of 50 mm)



FSC® C011234

RECORD OF BOREHOLE No BH 99-1

1 OF 1

METRIC

W.P. 82-91-00 LOCATION Highway 401, Cornwall, ON, Station 27+862 CL ORIGINATED BY  
DIST 41 HWY 401 BOREHOLE TYPE Hollow stem augers, split spoons COMPILED BY  
DATUM Geodetic DATE 16.12.99 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa	WATER CONTENT (%)					
55.5														
0.0	Sand with gravel, some silt, brown to light brown (FILL)		1	GS	-									
54.9														
0.6	PEAT with sand, trace gravel		2	SS	4									
			3	SS	1									
53.3														
2.2	CLAY, stiff, grey		4	SS	2									
			5	SS	1									
			6	SS	0									
49.4														
6.1	Gravelly sand with silt and clay, compact, grey (TILL)		7	SS	13									
48.7														
6.9	Auger Refusal End of Borehole Standpipe Installed  1st water level @ 0.61 m (99-12-16) 2nd water level @ 0.8 m (00-01-05)													

RECORD OF BOREHOLE No BH 99-2

1 OF 1

METRIC

W.P. 82-91-00 LOCATION Highway 401, Cornwall, Station 27+871, 10.0 Lt C/L ORIGINATED BY  
DIST 41 HWY 401 BOREHOLE TYPE Hollow stem augers, split spoons COMPILED BY  
DATUM Geodetic DATE CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100					
55.6 0.0	Silty sand, trace asphalt, very loose, brown (FILL)		1	SS	2												
54.9 0.7	PEAT, silty, fibrous, dark brown to black		2	SS	2												
			3	SS	1												
53.5 2.1	CLAY, firm to stiff, bluish grey		4	SS	5												
50.6 5.6	Sandy silt, loose, grey (TILL)		5	SS	6												
5.2	End of Borehole																

MT0 11284.GPJ ON MOT GDT 23/10/00

RECORD OF BOREHOLE No BH 99-3

1 OF 1

METRIC

W.P. 82-91-00 LOCATION Highway 401, Cornwall, Station 27+869, 20.0 Lt C/L ORIGINATED BY  
DIST 41 HWY 401 BOREHOLE TYPE Hollow stem augers, split spoons COMPILED BY  
DATUM Geodetic DATE 14.12.99 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT w <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa	WATER CONTENT (%)					
55.6	Tall Weeds		1	SS	3									
0.0	Peat		2	SS	2									
			3	SS	1									
53.2	CLAY, firm, grey		4	SS	2									
2.4			5	SS	1									
50.7			6	SS	13									
4.9	Silty sand with gravel, trace clay, compact, grey (TILL)		7	SS	17									
			8	SS	66									
48.9	- very wet		9	BQ	-									
6.7	LIMESTONE		10	BQ	-									
			11	BQ	-									
46.5	End of Borehole													
9.1	Standpipe Installed													
	Water level @ 0.33 m (00-01-05)													

MTD 11284.GPJ ON MOT.GDT 23/10/00



RECORD OF BOREHOLE No BH 99-4

1 OF 1

METRIC

W.P. 82-91-00 LOCATION Highway 401, Cornwall, Station 27+866, 32.0 Lt C/L ORIGINATED BY  
DIST 41 HWY 401 BOREHOLE TYPE Hollow stem augers, split spoons COMPILED BY  
DATUM Geodetic DATE - 14.12.99 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100		
55.5														
0.0	Sandy silt, some organics, loose, brown (FILL)		1	SS	6		55						49.1	
55.0			2	SS	3								110	
0.6	Silt, fibrous organic PEAT, dark brown		3	SS	3		54						150.1	
			4	SS	4								45.6	
53.2													615.1	
2.4	CLAY, firm to stiff, bluish grey		5	SS	2		53						58.7	
							52							
							51							
50.4														
50.4	Inferred silty sand (TILL)													
50.4	End of Borehole													
5.2														

































MTD 11284.GPJ ON MOT.GDT 23/10/00

# RECORD OF BOREHOLE No BH 99-5

1 OF 1

**METRIC**

W.P. 82-91-00 LOCATION Highway 401, Cornwall, Station 27+865, 41.0 Lt C/L ORIGINATED BY \_\_\_\_\_  
 DIST 41 HWY 401 BOREHOLE TYPE Hollow stem augers, split spoons COMPILED BY \_\_\_\_\_  
 DATUM Geodetic DATE - 14.12.99 CHECKED BY \_\_\_\_\_

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT w <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100					
56.0																	
0.0	PEAT, silty, fibrous, dark brown to black		1	SS	3												
			2	SS	5												
			3	SS	4												
			4	SS	3												
53.6																	
2.4	CLAY, firm to stiff, bluish grey																
																	
																	
																	
																	
																	
																	
																	
																	
																	
																	
																	
																	
																	
																	
																	
																	
																	
																	
																	
																	
																	
																	
																	
																	
																	
																	
48.8																	
48.7	Inferred silty sand (TILL)																
7.3	End of Borehole																

# RECORD OF BOREHOLE No BH 99-6

1 OF 1

METRIC

W.P. 82-91-00 LOCATION Highway 401, Cornwall, Station 27+871, 50.0 Lt C/L ORIGINATED BY  
DIST 41 HWY 401 BOREHOLE TYPE Hollow stem augers, split spoons COMPILED BY  
DATUM Geodetic DATE 15.12.99 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100	W <sub>p</sub>	W	W <sub>L</sub>		
55.3 0.0	PEAT, fibrous, dark brown to black		1	SS	3												
			2	SS	2												
53.0 2.3	CLAY, firm to stiff, bluish grey		3	SS	2												
49.5 48.8 5.9	Inferred silty sand (TILL) End of Borehole																

MT0 11284.GPJ ON\_MOT.GDT 23/10/00

RECORD OF BOREHOLE No BH 99-7

1 OF 1

METRIC

W.P. 82-91-00 LOCATION Highway 401, Cornwall, Station 27+869, 62.0 Lt C/L ORIGINATED BY  
DIST 41 HWY 401 BOREHOLE TYPE Hollow stem augers, split spoons COMPILED BY  
DATUM Geodetic DATE 15.12.99 CHECKED BY











SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa												
						○ UNCONFINED      × FIELD VANE ● QUICK TRIAXIAL    × LAB VANE					WATER CONTENT (%)									
						20	40	60	80	100	20	40	60	80	100	10	20	30		
55.7	0.0	PEAT, fibrous, dark brown to black		1	SS	3														
				2	SS	3														
53.4	2.3	CLAY, firm to stiff, bluish grey		3	SS	7														
50.1		Inferred silty sand (TILL)																		
50.0		End of Borehole																		
5.7																				

# RECORD OF BOREHOLE No BH 99-8

1 OF 1

METRIC

W.P. 82-91-00 LOCATION Highway 401, Cornwall, Station 27+870, 71.0 Lt C/L ORIGINATED BY  
DIST 41 HWY 401 BOREHOLE TYPE Hollow stem augers, split spoons COMPILED BY  
DATUM Geodetic DATE 16.12.99 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa							WATER CONTENT (%)
								○ UNCONFINED ● QUICK TRIAXIAL	× FIELD VANE × LAB VANE						
55.9	Tall Weeds						20 40 60 80 100								
0.0	PEAT		1	SS	2		55						53.8		
			2	SS	2		54							108.1	
			3	SS	1									72.5	
53.6	CLAY, soft to firm, grey		4	SS	3		53						50.8		
2.3			5	SH	-		52	4.0					62.5	15.4	
							51	3.3							
51.3	Sand and gravel, some silt, some clay, compact, grey (TILL)		6	SS	11		50								
4.6			7	SS	17										
	- silty sand layer 6.1 m to 6.3 m		8	SS	50/ 130										
49.3	Auger Refusal														
6.6	End of Borehole														
	Standpipe Installed														
	Water level @ 0.72 m (00-01-05)														

MT0 11284.GPJ ON\_MOT.GDT 23/10/00



# RECORD OF BOREHOLE No BH 99-10

1 OF 1

METRIC

W.P. 82-91-00 LOCATION Highway 401, Cornwall, Station 27+868, 87.0 Lt C/L ORIGINATED BY  
DIST 41 HWY 401 BOREHOLE TYPE Hollow stem augers, split spoons COMPILED BY  
DATUM Geodetic DATE 16.12.99 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60						80
55.7 0.0	Tall Weeds															
	see log from BH 99-10B															
52.6 3.1	CLAY, soft to firm, grey		1	SH	-											
50.9 4.8	Sand and gravel, trace silt, compact, grey (TILL)		2	SS	16											
			3	SS	21											
49.0 6.7	Auger Refusal End of Borehole Standpipe Installed Water level @ 0.51 m (00-01-05)		4	SS	42											

MT0 11284.GPJ ON\_MOT.GDT 23/10/00

# RECORD OF BOREHOLE No BH 99-10B

1 OF 1

METRIC

W.P. 82-91-00 LOCATION Highway 401, Cornwall, Station 27+868, 87.0 Lt C/L ORIGINATED BY  
 DIST 41 HWY 401 BOREHOLE TYPE Hollow stem augers, split spoons COMPILED BY  
 DATUM Geodetic DATE 15.12.99 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40						60	80	100
55.7 0.0	Sandy silt, loose, dark brown (FILL)		1	SS	6												
55.1 55.6 0.6	Silty clay, dark brown to grey (FILL) PEAT, fibrous, dark brown to black		2	SS	2												
53.7 2.0	CLAY, firm to stiff, bluish grey		3	SS	7												
51.3 54.4 4.5	Inferred silty sand (TILL) End of Borehole																

MTD 11284.GPJ ON MOT.GDT 23/10/00



# RECORD OF BOREHOLE No BH 99-11

1 OF 1

METRIC

W.P. 82-91-00 LOCATION Highway 401, Cornwall, Station 27+871, 98.0 Lt C/L ORIGINATED BY  
DIST 41 HWY 401 BOREHOLE TYPE Hollow stem augers, split spoons COMPILED BY  
DATUM Geodetic DATE 15.12.99 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT w <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100					
55.2																	
0.0	PEAT, silty, fibrous, dark brown to black	1	SS	1		55											
54.0		2	SS	1		54											
1.2	CLAY, firm, bluish grey	3	SS	7		53											
						52											
						51											
						50											
49.3																	
48.0	Inferred silty sand (TILL)																
6.0	End of Borehole																

MTD 11284.GPJ ON\_MOT.GDT 23/10/00



# RECORD OF BOREHOLE No BH 99-13

1 OF 1

METRIC

W.P. 82-91-00 LOCATION Highway 401, Cornwall, Station 27+863, 20.0 RT C/L ORIGINATED BY  
DIST 41 HWY 401 BOREHOLE TYPE Hollow stem augers, split spoons COMPILED BY  
DATUM Geodetic DATE 16.12.99 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa	WATER CONTENT (%)					
55.5	Tall Weeds in Peat													
0.0	Peat with silty sand, trace gravel, very loose, grey (FILL)		1	SS	2									
54.9														
0.6	PEAT		2	SS	1									
			3	SS	1									
53.2														
2.3	CLAY, firm, grey		4	SS	4									
			5	SS	1									
			6	SS	0									
49.4														
6.1	Gravel with sand, some silty clay, loose (TILL)		7	SS	8									
48.6			8	SS	50/50									
6.9	Sand and gravel, dense (TILL)													
48.0														
7.5	LIMESTONE		9	BQ	-									
			10	BQ	-									
45.0														
10.5	End of Borehole													
	Standpipe Installed													
	1st water level @ 0.91 m (99-12-16)													
	2nd water level @ 0.14 m (00-01-05)													

MTO 11284 GPJ ON MOT GDT 23/10/00

## 1 OF 1

## METRIC


DATUM Geodetic DATE 16.12.99 CHECKED BY \_\_\_\_\_

+ 3, × 3: Numbers refer to Sensitivity      ○ 3% STRAIN AT FAILURE

**METRIC**[illegible]

## 1 OF 1

METRIC

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT	UNIT WEIGHT $\gamma$	REMARKS & GRAIN SIZE DISTRIBUTION (%)				
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE			"N" VALUES	20					40	60	80	100
							SHEAR STRENGTH kPa									
55.5							○ UNCONFINED ● QUICK TRIAXIAL	× FIELD VANE × LAB VANE	WATER CONTENT (%) 10   20   30			$w_p$ $w$ $w_L$	GR   SA   SI   CL   ML   OL			

[illegible]

MTO 11284.GPJ ON\_MOT.GDT 23/10/00

+ 3, × 3: Numbers refer to Sensitivity      ○ 3% STRAIN AT FAILURE

RECORD OF BOREHOLE No BH 99-17

1 OF 1

METRIC

W.P. 82-91-00 LOCATION Highway 401, Cornwall, Station 27+860, 62.0 RT C/L ORIGINATED BY  
DIST 41 HWY 401 BOREHOLE TYPE Hollow stem augers, split spoons COMPILED BY  
DATUM Geodetic DATE 17.12.99 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT w <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
55.4	Tall Weeds and Cattails							○ UNCONFINED	× FIELD VANE					
0.0	PEAT		1	SS	2			● QUICK TRIAXIAL	× LAB VANE					
			2	SS	0									
53.8														
1.6	CLAY, firm, grey		3	SS	1									
			4	SS	2									
			5	SH	-									
			6	SH	-									
49.0	Sand up augers		7	SS	50/0									
6.4	Gravelly sand, dense, grey (TILL)													
48.7														
6.7	Auger Refusal													
	End of Borehole													
	Standpipe Installed													
	Water level @ 0.32 m (00-01-05)													

MT0 11284.GPJ ON\_MOT.GDT 01/11/00

## 1 OF 1

METRIC

DATUM	Geodetic	DATE	16.12.99	CHECKED BY
-------	----------	------	----------	------------

+ 3, × 3: Numbers refer to Sensitivity      ○ 3% STRAIN AT FAILURE



# RECORD OF BOREHOLE No BH 99-21

1 OF 1

METRIC

W.P. 82-91-00 LOCATION Highway 401, Cornwall, Station 27+850 C/L ORIGINATED BY  
DIST 41 HWY 401 BOREHOLE TYPE Hollow stem augers, split spoons COMPILED BY  
DATUM Geodetic DATE 14.12.99 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100		
55.6	Tall Grass													
55.8	Organics													
	Sandy silt with organics, trace gravel, loose, brown (FILL)		1	SS	5		55							
			2	SS	9									
			3	SS	6		54							
53.6	PEAT, brown		4	SS	9									
53.0							53							
2.6	CLAY, soft to stiff, grey		5	SS	3									
							52							
			6	SS	1									
							51							
							50							
49.6			7	SS	1									
5.9	Sand, some silt, trace gravel, loose, grey (TILL)						49							
48.9			8	SS	9									
6.7	End of Borehole													

RECORD OF BOREHOLE No BH 99-22

1 OF 1

METRIC

W.P. 82-91-00 LOCATION Highway 401, Cornwall, Station 27+841 C/L ORIGINATED BY  
DIST 41 HWY 401 BOREHOLE TYPE Hollow stem augers, split spoons COMPILED BY  
DATUM Geodetic DATE 14.12.99 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa	WATER CONTENT (%)					
56.6	Tall Grass		1	SS	11									
0.0	Sandy silt, some gravel, trace organics, compact, brown (FILL)		2	SS	50/130									
			3	SS	61									
			4	SS	24									
			5	SS	8									
53.3	PEAT		6	SS	7									
53.2	CLAY, firm, grey													
3.3			7	SS	3									
49.8			8	SS	1									
6.7	Coarse sand, some gravel, trace silt, compact, grey (TILL)		9	SS	22									
49.2														
7.3	End of Borehole													

RECORD OF BOREHOLE No BH 99-23

1 OF 1

METRIC

W.P. 82-91-00 LOCATION Highway 401, Cornwall, Station 27+830 C/L ORIGINATED BY  
DIST 41 HWY 401 BOREHOLE TYPE Hollow stem augers, split spoons COMPILED BY  
DATUM Geodetic DATE 15.12.99 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	20 40 60 80 100	20 40 60 80 100	20 40 60 80 100	20 40 60 80 100		
57.3	Tall Grass and Weeds		1	SS	7		57							
0.0	Sandy silt, trace gravel, trace clay, trace organics, loose, brown (FILL)		2	SS	7		56							
			3	SS	6		55							
			4	SS	6		54							
			5	SS	12		53							
53.3	PEAT		6	SS	6		52							
4.0			7	SS	4		51							
52.7	CLAY, stiff, grey		8	SS	1		50							
4.6			9	SS	1		49							
			10		46		48							
50.0	CLAY, silty, some sand, firm, grey		11		50/50									
7.3														
48.2	Sand and gravel, some clay, dense, grey (TILL)													
9.1														
47.2	End of Borehole Auger Refusal @ 10.1 m													
10.1														

+3, x3: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

RECORD OF BOREHOLE No BH 99-24

1 OF 1

METRIC

W.P. 82-91-00 LOCATION Highway 401, Cornwall, Station 27+811 C/L ORIGINATED BY  
DIST 41 HWY 401 BOREHOLE TYPE Hollow stem augers, split spoons COMPILED BY  
DATUM Geodetic DATE 14.12.99 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT   NATURAL MOISTURE   LIQUID LIMIT LIMIT   CONTENT   LIMIT w <sub>p</sub> w   w <sub>L</sub>			UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR   SA   SI   CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED   × FIELD VANE ● QUICK TRIAXIAL   × LAB VANE		WATER CONTENT (%) 20   40   60   80   100 10   20   30					
57.7	Tall Grass														
0.0	Sandy silt, trace organics, loose, brown (FILL)		1	SS	9		57								
			2	SS	6		56								
			3	SS	17		55								
55.4			4	SS	8		54								
2.3	Sand and gravel, compact, grey (FILL)		5	SS	27		53								
			6	SS	25		52								
			7	SS	18		51								
			8	SS	18		50								
51.6	- trace peat														
6.1	CLAY, firm to stiff, grey		9	SS	1		51								
			10	SS	1		50								
48.6							49								
9.1	Sand and gravel, some silt, dense, grey (TILL)		11	SS	18										
			12	SS	44										
			13	SS	50/ 0										
46.4							48								
11.3	End of Borehole Auger refusal						47								

MTD 11284.GPJ ON MOT.GDT 23/10/00







RECORD OF BOREHOLE No BH 99-28

1 OF 1

METRIC

W.P. 82-91-00 LOCATION Highway 401, Cornwall, Station 27+804, 54.0 RT C/L ORIGINATED BY  
DIST 41 HWY 401 BOREHOLE TYPE Hollow stem augers, split spoons COMPILED BY  
DATUM Geodetic DATE 20.12.99 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT w <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
						○ UNCONFINED    × FIELD VANE ● QUICK TRIAXIAL    × LAB VANE					WATER CONTENT (%)						
						20	40	60	80	100	10	20	30				
56.5 0.0	Sandy silt, some gravel, trace cobbles, loose, brown (FILL)		1	SS	7												
54.5 2.0	PEAT, fibrous, brown		2	SS	6												
53.2 3.3	CLAY, firm, bluish grey		3	SS	4												
50.0 6.6	Sandy silt, trace gravel, dense, grey (TILL)		4	SS	3												
48.6 7.9	Auger Refusal End of Borehole		8	SS	50+												



RECORD OF BOREHOLE No BH 99-29

1 OF 1

METRIC

W.P. 82-91-00 LOCATION Highway 401, Cornwall, Station 27+766, 63.0 RT C/L ORIGINATED BY  
DIST 41 HWY 401 BOREHOLE TYPE Hollow stem augers, split spoons COMPILED BY  
DATUM Geodetic DATE 20.12.99 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100					
56.9 0.1	TOPSOIL Silt, some gravel, trace cobbles, loose, brownish grey (FILL)																
55.0 1.9	PEAT, fibrous, dark brown		1	SS	8												
			2	SS	5												
52.2 4.7	CLAY, firm, grey		3	SS	2												
49.8 7.1	Gravelly sand, trace silt, dense, grey (TILL)																
49.0 7.9	Auger Refusal End of Borehole Water level @ 1.70 m (00-01-05)		4	SS	50+												

MT0 11284.GPJ ON\_MOT.GDT 23/10/00

RECORD OF BOREHOLE No BH 99-30

1 OF 1

METRIC

W.P. 82-91-00 LOCATION Highway 401, Cornwall, Station 27+787, 60.0 Lt C/L ORIGINATED BY  
DIST 41 HWY 401 BOREHOLE TYPE Hollow stem augers, split spoons COMPILED BY  
DATUM Geodetic DATE 20.12.99 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT w <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED × FIELD VANE ● QUICK TRIAXIAL × LAB VANE									
							20	40	60	80	100						
55.8 0.0	PEAT, silty, fibrous, dark brown to black																
			1	SS	2												
52.7 3.2	CLAY, firm, grey		2	SS	2												
			3	SS	1												
48.2 7.6	Auger Refusal End of Borehole																

RECORD OF BOREHOLE No BH 99-31

1 OF 1

METRIC

W.P. 82-91-00 LOCATION Highway 401, Cornwall, Station 27+870 C/L ORIGINATED BY  
DIST 41 HWY 401 BOREHOLE TYPE Hollow stem augers, split spoons COMPILED BY  
DATUM Geodetic DATE 17.12.99 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100		
55.6	Tall Weeds and Grass													
55.0	PEAT Sandy silt, trace gravel, some organics, loose, light brown		1	SS	3									
54.5														
54.1	PEAT		2	SS	12									
			3	SS	1									
53.3														
52.3	CLAY, firm, grey		4	SS	2									
			5	SS	-									
			6	SS	1									
49.5														
6.1	Silty sand and gravel, trace clay, compact, grey (TILL)		7	SS	13									
48.9														
6.7	End of Borehole													

MTD 11284.GPJ ON MOT.GDT 23/10/00

RECORD OF BOREHOLE No BH 99-33

1 OF 1

METRIC

W.P. 82-91-00 LOCATION Highway 401, Cornwall, Station 27+890, C/L ORIGINATED BY  
DIST 41 HWY 401 BOREHOLE TYPE Hollow stem augers, split spoons COMPILED BY  
DATUM Geodetic DATE 20.12.99 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
57.5							20	40	60	80	100						
0.0	Sandy silt with organics, loose, brown (FILL)		1	SS	7												
56.9																	
0.6	Sandy silt, trace gravel, loose, brown (FILL)																
			2	SS	8												
			3	SS	10												
52.9																	
4.6	CLAY, stiff, grey		4	SS	7												
51.4																	
50.3	SILTY CLAY, trace gravel, trace sand, grey																
6.2	Sand, some gravel, some silt, compact, grey (TILL)																
			5	SS	10												
			6	SS	50/ 80												
49.0																	
8.5	Auger Refusal @ 8.5 m End of Borehole																

RECORD OF BOREHOLE No BH 99-34

1 OF 1

METRIC

W.P. 82-91-00 LOCATION Highway 401, Cornwall, Station 27+910 C/L ORIGINATED BY  
DIST 41 HWY 401 BOREHOLE TYPE Hollow stem augers, split spoons COMPILED BY  
DATUM Geodetic DATE 20.12.99 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60						80
58.1	Tall Grass and Weeds															
56.0	Sandy silt, trace gravel, some organics (FILL) Sandy silt, trace gravel, compact, brown (FILL)		1	SS	9											
			2	SS	12											
			3	SS	16											
54.2	Coarse sand with gravel, compact, grey		4	SS	19											
52.0	Sand, some gravel, some clay, trace silt, dense, grey (FILL)		5	SS	50											
51.3	Sand, some gravel, dense, grey (TILL)		6	SS	69											
48.5	Auger Refusal End of Borehole															

MTO 11284.GPJ ON MOT.GDT 23/10/00

# RECORD OF BOREHOLE No BH 99-35

1 OF 1

METRIC

W.P. 82-91-00 LOCATION Highway 401, Cornwall, Station 27+925 C/L ORIGINATED BY  
DIST 41 HWY 401 BOREHOLE TYPE Hollow stem augers, split spoons COMPILED BY  
DATUM Geodetic DATE 20.12.99 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT w <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40						60	80
59.4	Tall Grass and Weeds															
0.0	Sandy silt, trace gravel, trace organics, loose, brown (FILL)		1	SS	5											
57.8																
1.5	Sandy silt, trace gravel, compact, grey (FILL)		2	SS	16											
56.3																
3.1	Gravel and sand, compact, grey (FILL)		3	SS	12											
			4	SS	28											
			5	SS	28											
51.7																
7.7	CLAY, stiff, grey		6	SS	6											
50.7																
8.7	Sand, trace gravel, dense, grey (TILL)		7	SS	50/100											
			8	SS	50/50											
48.1																
11.3	Auger Refusal @ 11.3 m End of Borehole Standpipe Installed 1st water level @ 4.57 m (99-12-20) 2nd water level @ 1.9 m (00-01-05)															

MT0 11284.GPJ ON MOT.GDT 23/10/00

RECORD OF BOREHOLE No BH 99-36

1 OF 1

METRIC

W.P. 82-91-00 LOCATION Highway 401, Cornwall, Station 27+942, 35.0 RT C/L ORIGINATED BY  
DIST 41 HWY 401 BOREHOLE TYPE Hollow stem augers, split spoons COMPILED BY  
DATUM Geodetic DATE 21.12.99 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT w <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40						60	80
56.2	Weeds and Brush															
0.0	TOPSOIL, dark brown		1	SS	2		56									
55.6																
0.6	Silty sand and organics, loose, dark brown (FILL)		2	SS	5		55									
53.1							54									
3.1	Sand and gravel, some silt, compact, grey (FILL)		3	SS	21		53									
51.6							52									
4.6	Silty sand, trace gravel, trace clay, dense, grey (TILL)		4	SS	20/ 100		51									
			5	SS	50/ 50		50									
49.1																
7.0	Auger Refusal @ 7 m End of Borehole Standpipe installed Water level @ 0.52m (00-01-05)															

# RECORD OF BOREHOLE No BH 99-37

1 OF 1

METRIC

W.P. 82-91-00 LOCATION Highway 401, Cornwall, Station 27+921, 33.0 RT C/L ORIGINATED BY  
DIST 41 HWY 401 BOREHOLE TYPE Hollow stem augers, split spoons COMPILED BY  
DATUM Geodetic DATE 21.12.99 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)					
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					WATER CONTENT (%)									
							20	40	60	80	100	20	40	60	80	100	10	20	30			
55.6 0.0	Tall Weeds and Brush PEAT		1	SS	2																	
			2	SS	3																	
52.6 3.1	CLAY, firm to stiff, grey		3	SS	1																	
51.1 4.6	Sand and gravel, trace silt, dense, grey (TILL)		4	SS	40																	
			5	SS	50/ 80																	
48.5 7.2	Auger Refusal @ 7.1 m End of Borehole																					

MT0 11284.GPJ ON\_MOT.GDT 23/10/00



### METRIC

[illegible]

+ 3, × 3: Numbers refer to Sensitivity      ○ 3% STRAIN AT FAILURE

RECORD OF BOREHOLE No BH 99-39

1 OF 1

METRIC

W.P. 82-91-00 LOCATION Highway 401, Cornwall, Station 27+929, 51.0 Lt C/L ORIGINATED BY  
DIST 41 HWY 401 BOREHOLE TYPE Hollow stem augers, split spoons COMPILED BY  
DATUM Geodetic DATE 21.12.99 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>P</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa										WATER CONTENT (%)		
								○ UNCONFINED	× FIELD VANE	● QUICK TRIAXIAL	× LAB VANE	20						40	60	80
56.6	Tall Grass and Brush																			
0.0	Sandy silt, some organics, trace gravel, loose, brown (FILL)		1	SS	8	▽	56													
54.5			2	SS	4		55													
2.1	Silty clay, grey (FILL)						54													
53.5																				
3.1	PEAT		3	SS	2		53													
53.2																				
3.4	CLAY, firm, grey						52													
				4	SS	1														
50.4							51													
6.2	Sand with silt, compact, grey (TILL)		5	SS	11															
48.4			6	SS	36		49													
8.2	End of Borehole																			

MT0 11284.GPJ ON MOT.GDT 23/10/00

RECORD OF BOREHOLE No BH 99-40

1 OF 1

METRIC

W.P. 82-91-00 LOCATION Highway 401, Cornwall, Station 27+945 C/L ORIGINATED BY  
DIST 41 HWY 401 BOREHOLE TYPE Hollow stem augers, split spoons COMPILED BY  
DATUM Geodetic DATE 13.12.99 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	20 40 60 80 100	10 20 30					
63.2	50 mm sand with silt, trace gravel, dark brown (TOPSOIL)		1	SS	4										
	Sand, some silt, some gravel, loose, light brown (FILL)		2	SS	6										
			3	SS	26										
61.3	Sand with gravel, some silt, compact, brown (FILL)		4	SS	15										
60.7	Silty sand with gravel, compact to dense, brown (FILL)		5	SS	58										
60.7			6	SS	18										
			7	SS	81									18 44 38 -	
			8	SS	16										
			9	SS	100/ 250										
54.0	Sandy silt, trace gravel, compact, brown (FILL)		10	SS	20										
53.1	CLAY, firm, grey														
51.9			11	SS	7										
11.3	End of Borehole														

MT0 11284.GPJ ON\_MOT.GDT 23/10/00






# RECORD OF BOREHOLE No PH 99-2

1 OF 1

METRIC

W.P. 82-91-00 LOCATION Highway 401, Cornwall, Station 27+860, 40.0 Lt C/L ORIGINATED BY \_\_\_\_\_  
 DIST 41 HWY 401 BOREHOLE TYPE Solid stem COMPILED BY \_\_\_\_\_  
 DATUM Geodetic DATE 17.12.99 CHECKED BY \_\_\_\_\_

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL						
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa					WATER CONTENT (%)									
							20	40	60	80	100	20	40	60	80	100	10	20	30			
56.4 0.0	PEAT, fibrous, dark brown to black																					
54.6 54.8	CLAY, firm, bluish grey																					
2.0	End of Probe Hole																					

MTO 11284.GPJ ON MOT GDT 23/10/00

RECORD OF BOREHOLE No PH 99-3

1 OF 1

METRIC

W.P. 82-91-00 LOCATION Highway 401, Cornwall, Station 27+875, 40.0 Lt C/L ORIGINATED BY  
DIST 41 HWY 401 BOREHOLE TYPE Solid stem COMPILED BY  
DATUM Geodetic DATE 17.12.99 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED × FIELD VANE ● QUICK TRIAXIAL × LAB VANE					W <sub>p</sub>	W	W <sub>L</sub>		
							20	40	60	80	100						
55.6																	
0.0	PEAT, fibrous, dark brown to black	1/1															
		1/1															
		1/1															
		1/1															
		1/1															
		1/1															
52.6		1/1															
52.6	CLAY, firm, bluish grey	1/1															
3.1	End of Probe Hole	1/1															

# RECORD OF BOREHOLE No PH 99-4

1 OF 1

METRIC

W.P. 82-91-00 LOCATION Highway 401, Cornwall, Station 27+895, 40.0 Lt C/L ORIGINATED BY  
DIST 41 HWY 401 BOREHOLE TYPE Solid stem COMPILED BY  
DATUM Geodetic DATE 17.12.99 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100					
55.2 0.0	PEAT, fibrous, dark brown to black																
52.9 2.3	CLAY, firm, bluish grey																
52.2 3.0	End of Probe Hole																


MTO 11284.GPJ ON\_MOT.GDT 23/10/00

RECORD OF BOREHOLE No PH 99-5

1 OF 1

METRIC

W.P. 82-91-00 LOCATION Highway 401, Cornwall, Station 27+905, 40.0 Lt C/L ORIGINATED BY \_\_\_\_\_  
 DIST 41 HWY 401 BOREHOLE TYPE Solid stem COMPILED BY \_\_\_\_\_  
 DATUM Geodetic DATE 17.12.99 CHECKED BY \_\_\_\_\_

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED × FIELD VANE ● QUICK TRIAXIAL × LAB VANE					WATER CONTENT (%)				
							20	40	60	80	100	W <sub>p</sub>	W	W <sub>L</sub>			
57.1																	
0.0	Clayey silt, some sand, trace gravel, brown (FILL)																
55.6																	
1.5	End of Probe Hole																

MTD 11284.GPJ ON MOT.GDT 23/10/00




RECORD OF BOREHOLE No PH 99-6

1 OF 1

METRIC

W.P. 82-91-00 LOCATION Highway 401, Cornwall, station 27+915, 40.0 Lt C/L ORIGINATED BY  
DIST 41 HWY 401 BOREHOLE TYPE Solid stem COMPILED BY  
DATUM Geodetic DATE 17.12.99 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
						○ UNCONFINED      × FIELD VANE ● QUICK TRIAXIAL    × LAB VANE					WATER CONTENT (%)						
						20	40	60	80	100	10	20	30	kN/m <sup>3</sup>	GR SA SI CL		
57.3																	
56.9	ROOTMAT Clayey silt, some sand, trace gravel, brown (FILL)																
55.8																	
1.5	End of Probe Hole																


MTO 11284.GPJ ON MOT.GDT 23/10/00

RECORD OF BOREHOLE No PH 99-7

1 OF 1

METRIC

W.P. 82-91-00 LOCATION Highway 401, Cornwall, Station 27+925, 40.0 Lt C/L ORIGINATED BY \_\_\_\_\_  
 DIST 41 HWY 401 BOREHOLE TYPE Solid stem COMPILED BY \_\_\_\_\_  
 DATUM Geodetic DATE 17.12.99 CHECKED BY \_\_\_\_\_

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT w <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
						○ UNCONFINED    × FIELD VANE ● QUICK TRIAXIAL    × LAB VANE					WATER CONTENT (%)						
						20	40	60	80	100							
57.5																	
56.9	ROOTMAT Clayey silt, some sand, trace gravel, brown (FILL)																
56.0																	
1.5	End of Probe Hole																

MTO 11284.GPJ ON MOT.GDT 23/10/00

RECORD OF BOREHOLE No PH 99-8

1 OF 1

METRIC

W.P. 82-91-00 LOCATION Highway 401, Cornwall, Station 27+850, 20 Lt C/L ORIGINATED BY  
DIST 41 HWY 401 BOREHOLE TYPE Solid stem COMPILED BY  
DATUM Geodetic DATE 17.12.99 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT w <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED × FIELD VANE ● QUICK TRIAXIAL × LAB VANE									
						20	40	60	80	100							
57.6																	
0.0	Sand, some silt, trace gravel, trace cobbles, brown (FILL)																
57.2																	
0.4	PEAT, silty, dark brown to black		1	SA													
55.9																	
1.7	CLAYEY SILT, some sand, trace gravel, brownish grey		2	SA													
55.1																	
2.5	End of Probe Hole																

MTO 11284.GPJ ON MOT.GDT 23/10/00

## 1 OF 1

**METRIC**[illegible]

MTD 11284.GPJ ON\_MOT.GDT 23/10/00

+ 3, × 3: Numbers refer to Sensitivity      ○ 3% STRAIN AT FAILURE

RECORD OF BOREHOLE No PH 99-10

1 OF 1

METRIC

W.P. 82-91-00 LOCATION Highway 401, Cornwall, Station 27+875, 20.0 Lt C/L ORIGINATED BY  
DIST 41 HWY 401 BOREHOLE TYPE Solid stem COMPILED BY  
DATUM Geodetic DATE 17.12.99 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT w <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100					
56.1	ROOTMAT Clayey silt, some sand, trace gravel, brown (FILL)																
56.1																	
54.6																	
1.5	End of Probe Hole																

MT0 11284.GPJ ON\_MOT.GDT 23/10/00

RECORD OF BOREHOLE No PH 99-11

1 OF 1

METRIC

W.P. 82-91-00 LOCATION Highway 401, Cornwall, Station 27+894, 20.0 Lt C/L ORIGINATED BY  
DIST 41 HWY 401 BOREHOLE TYPE Solid stem COMPILED BY  
DATUM Geodetic DATE 17.12.99 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED × FIELD VANE ● QUICK TRIAXIAL × LAB VANE					WATER CONTENT (%) w <sub>p</sub> w w <sub>L</sub>				
							20	40	60	80	100						
56.5																	
56.0	ROOTMAT Clayey silt, some sand, trace gravel, brown (FILL)																
55.0																	
1.5	End of Probe Hole																

MT0 11284.GPJ ON\_MOT.GDT 23/10/00

# RECORD OF BOREHOLE No PH 99-12

1 OF 1

METRIC

W.P. 82-91-00 LOCATION Highway 401, Cornwall, Station 27+905, 20.0 Lt C/L ORIGINATED BY  
DIST 41 HWY 401 BOREHOLE TYPE Solid stem COMPILED BY  
DATUM Geodetic DATE 17.12.99 CHECKED BY

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT w <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa								
						○ UNCONFINED	× FIELD VANE	● QUICK TRIAXIAL	× LAB VANE							
						20	40	60	80	100						
56.9	ROOTMAT															
56.9	Clayey silt, some sand, trace gravel, brown (FILL)															
55.4																
1.5	End of Probe Hole															

MTO 11284.GPJ ON MOT GDT 23/10/00

RECORD OF BOREHOLE No PH 99-13

1 OF 1

METRIC

W.P. 82-91-00 LOCATION Highway 401, Cornwall, Station 27+830, 20.0 RT C/L ORIGINATED BY

DIST 41 HWY 401 BOREHOLE TYPE Solid stem COMPILED BY

DATUM Geodetic DATE 17.12.99 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100	$w_p$	$w$	$w_L$		
57.5	ROOTMAT Clayey silt, some sand, trace gravel, brown (FILL)		1	SA													
56.0	End of Probe Hole																

MT0 11284.GPJ ON\_MOT.GDT 23/10/00



RECORD OF BOREHOLE No PH 99-14

1 OF 1

METRIC

W.P. 82-91-00 LOCATION Highway 401, Cornwall, Station 27+838, 20.0 RT C/L ORIGINATED BY  
DIST 41 HWY 401 BOREHOLE TYPE Solid stem COMPILED BY  
DATUM Geodetic DATE 17.12.99 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100					
56.1	ROOTMAT																
56.0	Clayey silt, some sand, trace gravel, brown (FILL)																
54.6																	
1.5	End of Probe Hole																






MTO 11284.GPJ ON MOT.GDT 23/10/00

# RECORD OF BOREHOLE No PH 99-15

1 OF 1

**METRIC**

W.P. 82-91-00 LOCATION Highway 401, Cornwall, Station 27+852, 20.0 RT C/L ORIGINATED BY \_\_\_\_\_  
 DIST 41 HWY 401 BOREHOLE TYPE Solid stem COMPILED BY \_\_\_\_\_  
 DATUM Geodetic DATE 17.12.99 CHECKED BY \_\_\_\_\_

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC NATURAL LIQUID LIMIT MOISTURE CONTENT LIMIT			UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa					WATER CONTENT (%)				
							20	40	60	80	100	$w_p$	$w$	$w_L$			
55.5	PEAT, fibrous, dark brown to black																
0.0																	
54.0																	
53.8	CLAY, firm, bluish grey																
1.7	End of Probe Hole																





MTO 11284.GPJ ON MOT.GDT 23/10/00

# RECORD OF BOREHOLE No PH 99-16

1 OF 1

**METRIC**

W.P. 82-91-00 LOCATION Highway 401, Cornwall, Station 27+870, 20.0 RT C/L ORIGINATED BY \_\_\_\_\_  
 DIST 41 HWY 401 BOREHOLE TYPE Solid stem COMPILED BY \_\_\_\_\_  
 DATUM Geodetic DATE 17.12.99 CHECKED BY \_\_\_\_\_

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)						
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa					WATER CONTENT (%)									
							20	40	60	80	100	20	40	60	80	100	10	20	30			
56.1																						
0.0	PEAT, fibrous, dark brown to black																					
54.5																						
54.8	CLAY, firm, bluish grey																					
1.8	End of Probe Hole																					

RECORD OF BOREHOLE No PH 99-17

1 OF 1

METRIC

W.P. 82-91-00 LOCATION Highway 401, Cornwall, Station 27+800, 40.0 RT C/L ORIGINATED BY  
DIST 41 HWY 401 BOREHOLE TYPE Solid stem COMPILED BY  
DATUM Geodetic DATE 17.12.99 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT w <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)					
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa														
						○ UNCONFINED    × FIELD VANE ● QUICK TRIAXIAL    × LAB VANE					WATER CONTENT (%)											
						20	40	60	80	100	20	40	60	80	100	10	20	30	GR	SA	SI	CL
57.6																						
56.9	TOPSOIL Clayey silt, some sand, trace gravel, brown (FILL)																					
56.1																						
1.5	End of Probe Hole																					

# RECORD OF BOREHOLE No PH 99-18

1 OF 1

METRIC

W.P. 82-91-00 LOCATION Highway 401, Cornwall, Station 27+810, 40.0 RT C/L ORIGINATED BY  
DIST 41 HWY 401 BOREHOLE TYPE Solid stem COMPILED BY  
DATUM Geodetic DATE 17.12.99 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED × FIELD VANE ● QUICK TRIAXIAL × LAB VANE									
						20	40	60	80	100							
57.5	TOPSOIL Clayey silt, some sand, trace gravel, brown (FILL)																
56.0																	
1.5	End of Probe Hole																

RECORD OF BOREHOLE No PH 99-19

1 OF 1

METRIC

W.P. 82-91-00 LOCATION Highway 401, Cornwall, Station 27+818, 40.0 RT C/L ORIGINATED BY  
DIST 41 HWY 401 BOREHOLE TYPE Solid stem COMPILED BY  
DATUM Geodetic DATE 17.12.99 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT w <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100					
57.1	TOPSOIL																
58.9 0.2	Clayey silt, some sand, trace gravel, brown (FILL)																
55.3 1.8	End of Probe Hole																

MTD 11284.GPJ ON MOT.GDT 23/10/00

RECORD OF BOREHOLE No PH 99-20

1 OF 1

METRIC

W.P. 82-91-00 LOCATION Highway 401, Cornwall, Station 27+833, 40.0 RT C/L ORIGINATED BY  
DIST 41 HWY 401 BOREHOLE TYPE Solid stem COMPILED BY  
DATUM Geodetic DATE 17.12.99 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC NATURAL LIQUID LIMIT MOISTURE CONTENT LIMIT			UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100	W <sub>p</sub>	W	W <sub>L</sub>		
55.3																	
0.0	PEAT, fibrous, dark brown to black																
53.8																	
1.5	CLAY, firm, bluish grey		1	SA													
53.2																	
2.1	End of Probe Hole																



MTD 11284.GPJ ON MOT.GDT 23/10/00

# RECORD OF BOREHOLE No PH 99-21

1 OF 1

**METRIC**

W.P. 82-91-00 LOCATION Highway 401, Cornwall, Station 27+840, 40.0 RT C/L ORIGINATED BY \_\_\_\_\_  
 DIST 41 HWY 401 BOREHOLE TYPE Solid stem COMPILED BY \_\_\_\_\_  
 DATUM Geodetic DATE 17.12.99 CHECKED BY \_\_\_\_\_

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa					WATER CONTENT (%)				
							20	40	60	80	100	W <sub>p</sub>	W	W <sub>L</sub>			
55.2 0.0	PEAT, fibrous, dark brown to black																
53.8 1.5	CLAY, firm, bluish grey End of Probe Hole																

MT0 11284.GPJ ON MOT.GDT 23/10/00



RECORD OF BOREHOLE No PH 99-22

1 OF 1

METRIC

W.P. 82-91-00 LOCATION Highway 401, Cornwall, Station 27+850, 40.0 RT C/L ORIGINATED BY  
DIST 41 HWY 401 BOREHOLE TYPE Solid stem COMPILED BY  
DATUM Geodetic DATE 17.12.99 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT w <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
						○ UNCONFINED      × FIELD VANE ● QUICK TRIAXIAL    × LAB VANE					WATER CONTENT (%)						
						20	40	60	80	100							
55.3																	
0.0	PEAT, fibrous, dark brown to black																
53.8																	
1.5	CLAY, firm, bluish grey																
53.3																	
2.0	End of Probe Hole																

MTO 11284 GPJ ON MOT GDT 23/10/00

# RECORD OF BOREHOLE No PH 99-23

1 OF 1

METRIC

W.P. 82-91-00 LOCATION Highway 401, Cornwall, Station 27+860, 40.0 RT C/L ORIGINATED BY  
 DIST 41 HWY 401 BOREHOLE TYPE Solid stem COMPILED BY  
 DATUM Geodetic DATE 17.12.99 CHECKED BY

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL						
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa					WATER CONTENT (%)									
							20	40	60	80	100	20	40	60	80	100	10	20	30			
55.8																						
0.0	PEAT, fibrous, dark brown to black																					
54.1																						
53.8	CLAY, firm, bluish grey																					
2.0	End of Probe Hole																					

MTO 11284.GPJ ON MOT.GDT 23/10/00

RECORD OF BOREHOLE No PH 99-26

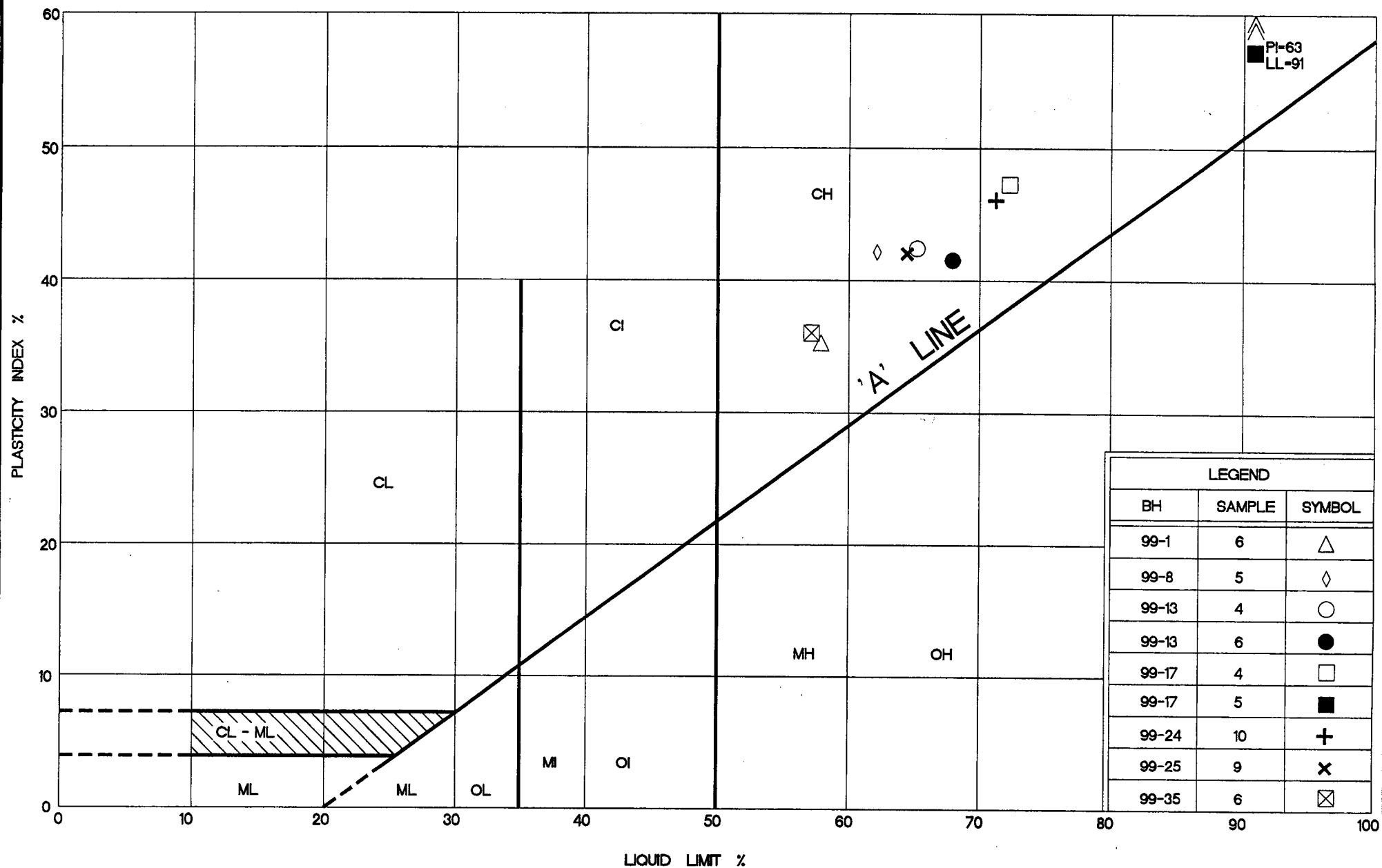
1 OF 1

METRIC

W.P. 82-91-00 LOCATION Highway 401, Cornwall ORIGINATED BY  
DIST 41 HWY 401 BOREHOLE TYPE Solid stem COMPILED BY  
DATUM Geodetic DATE CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED × FIELD VANE ● QUICK TRIAXIAL × LAB VANE									
0.0	Sandy silt, trace gravel to some gravel, brown to grey (FILL)																
6.1	CLAY, firm, grey																
7.6	End of Probe Hole																

MT0 11284.GPJ ON MOT.GDT 23/10/00



Ministry  
of  
Transportation  
Ontario

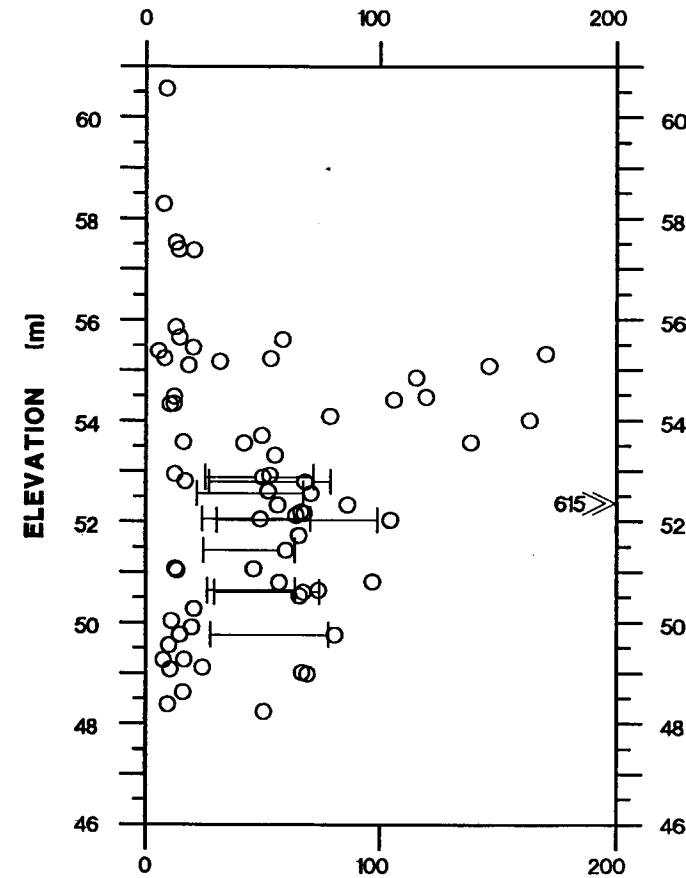
# PLASTICITY CHART CLAY OF HIGH PLASTICITY

FIG No 1

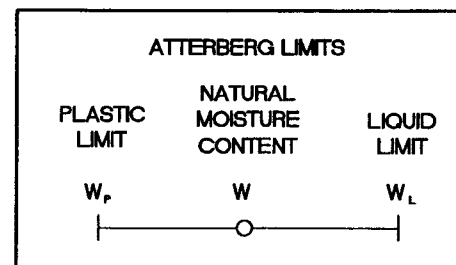
W P 82-91-00

705

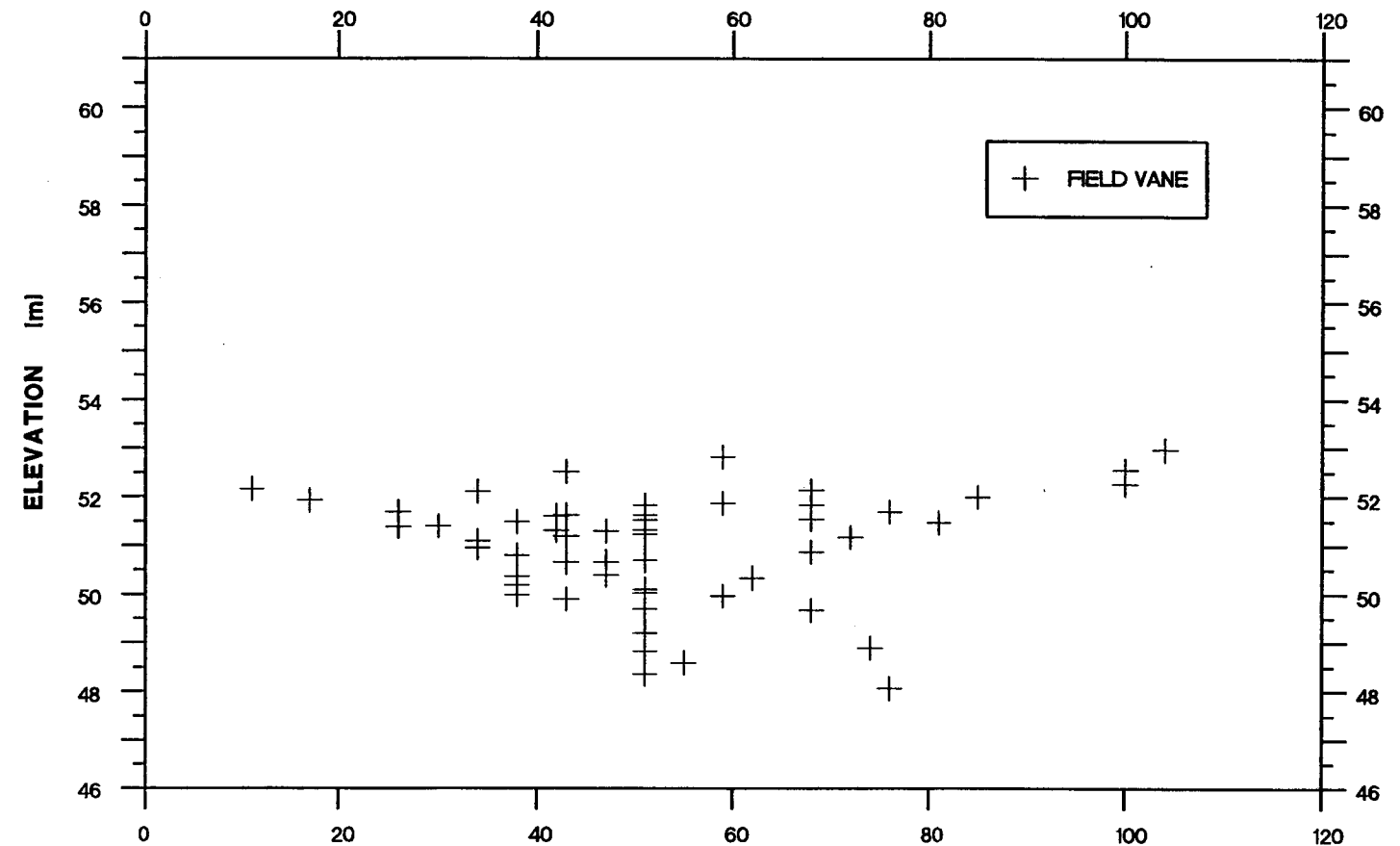
# WATER CONTENT (%)



## ATTERBERG LIMITS vs ELEVATION



# SHEAR STRENGTH (kPa)



## VANE SHEAR STRENGTH vs ELEVATION



**Jacques  
Whitford**

### REFERENCE :

BASE PLAN PROVIDED BY  
A. DAGENAI AND ASSOCIATES INC.

### SCALE :

1 : 750

### DATE :

00/01/17

### DWN. BY :

JAZ

### APP'D BY :

*[Signature]*

MTO

GEOTECHNICAL INVESTIGATION  
HIGHWAY 401

CORNWALL

ONTARIO

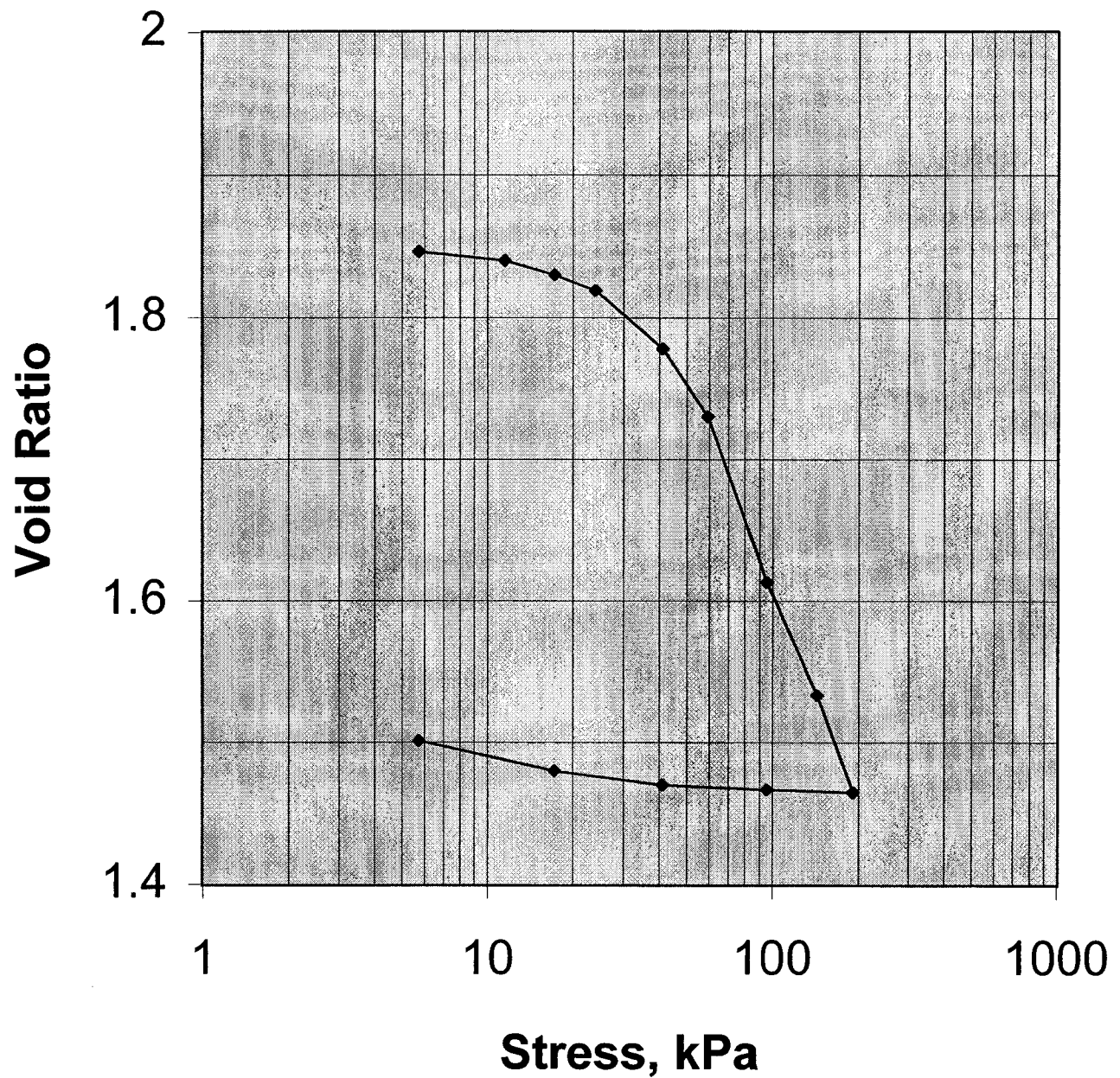
ATTERBERG LIMITS AND SHEAR  
STRENGTH vs ELEVATION

### FIGURE No.:

2

11284-F102

# Consolidation Test

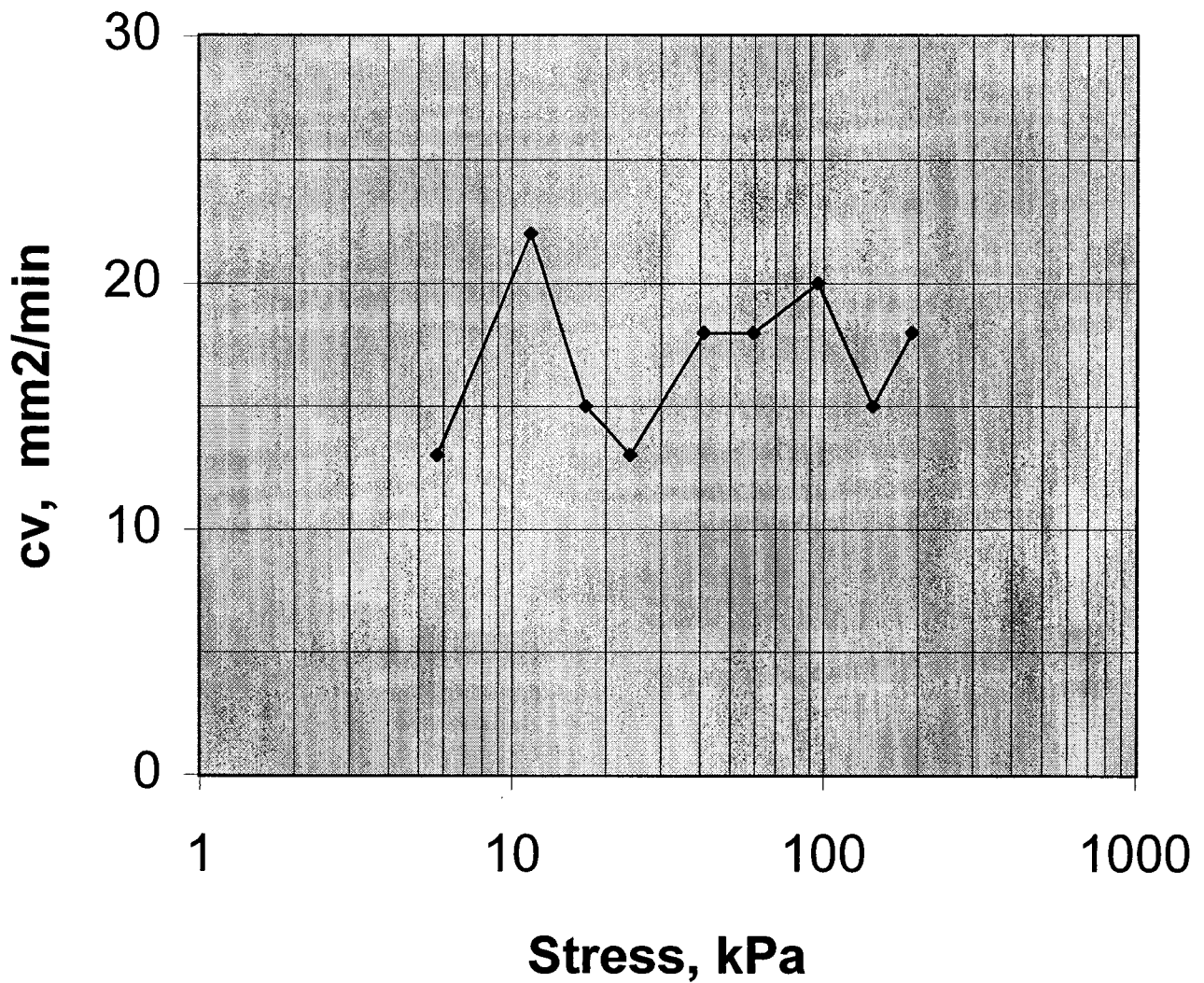


Depth: 3.05 m  
Natural Moisture 65%  
wL 62%, wP 20%  
Initial Void Ratio 1.84  
Unit Weight 1571 kg/m<sup>3</sup>  
Initial Effective Stress 18 kPa  
Preconsolidation Pressure 60 kPa  
Compression Index 0.56  
Recompression Index 0.05

BH 99-8, SH-5

Figure 3

# Consolidation Test

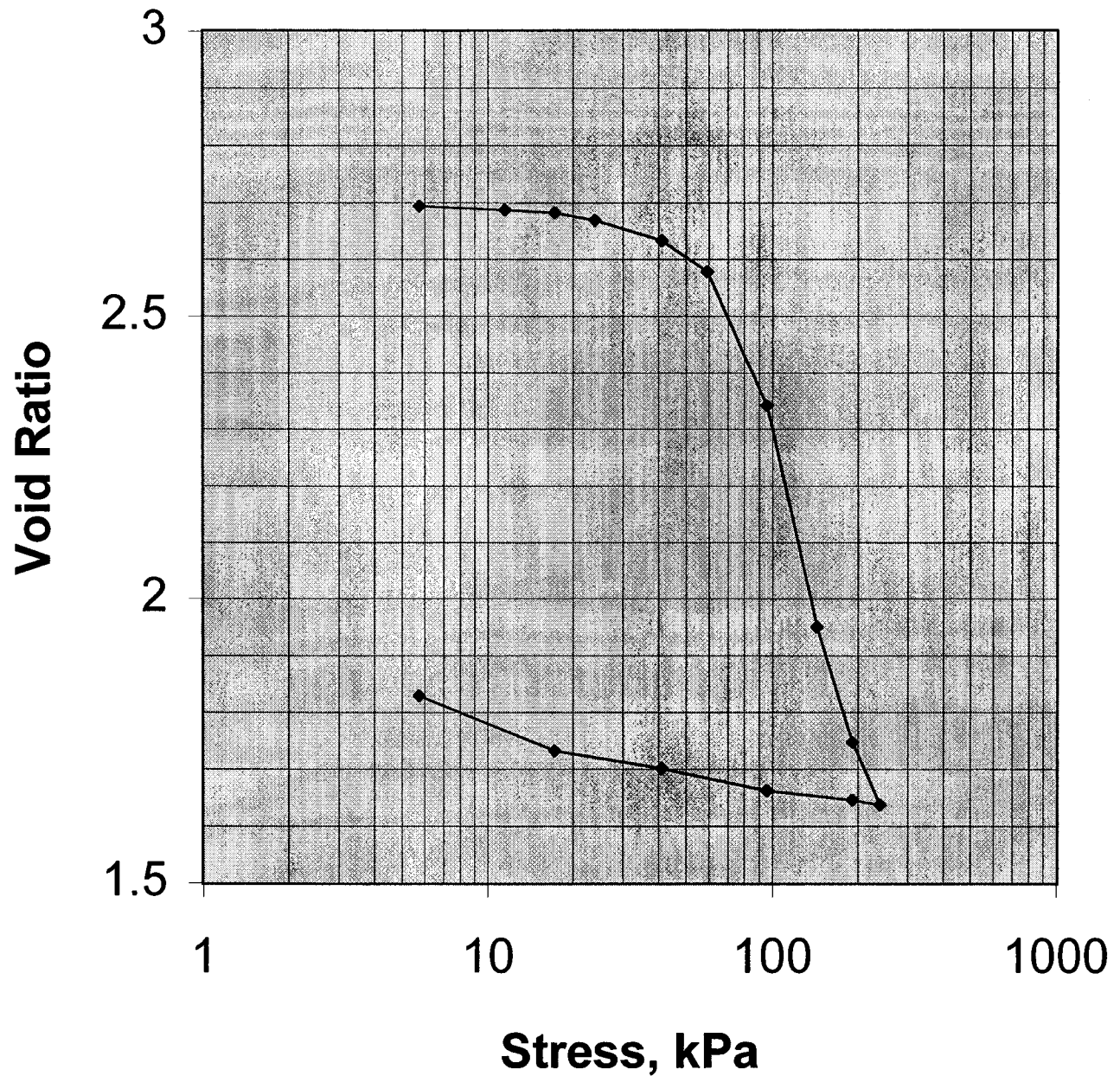


Depth 3.05 m  
Natural Moisture Content 65%  
Liquid Limit 62%, Plastic Limit 20%  
Initial Void Ratio 1.84  
Unit Weight 1571 kg/m<sup>3</sup>

BH 99-8, SH-5

Figure 4

# Consolidation Test



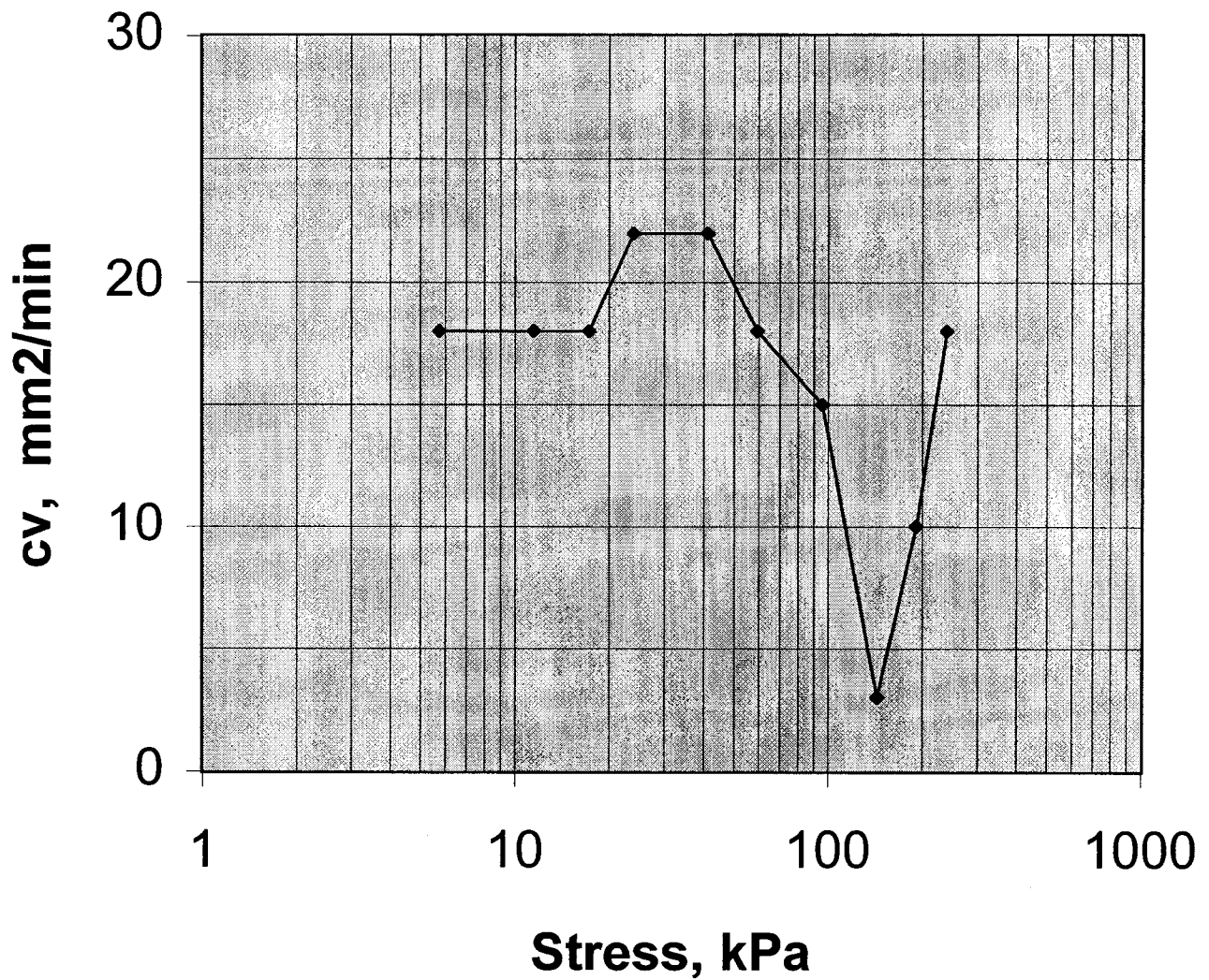
Depth: 3.05 m  
Natural Moisture 96%  
wL 91%, wP 28%  
Initial Void Ratio 2.69  
Unit Weight 1434 kg/m<sup>3</sup>  
Initial Effective Stress 14 kPa  
Preconsolidation Stress 80 kPa  
Compression Index 2.49  
Recompression Index 0.06

BH 99-17, SH-5

Figure 5



# Consolidation Test



Depth 3.05 m  
Natural Moisture Content 96%  
Liquid Limit 91%, Plastic Limit 28%  
Initial Void Ratio 2.69  
Unit Weight 1434 kg/m<sup>3</sup>

BH 99-17, SH-5

Figure 6

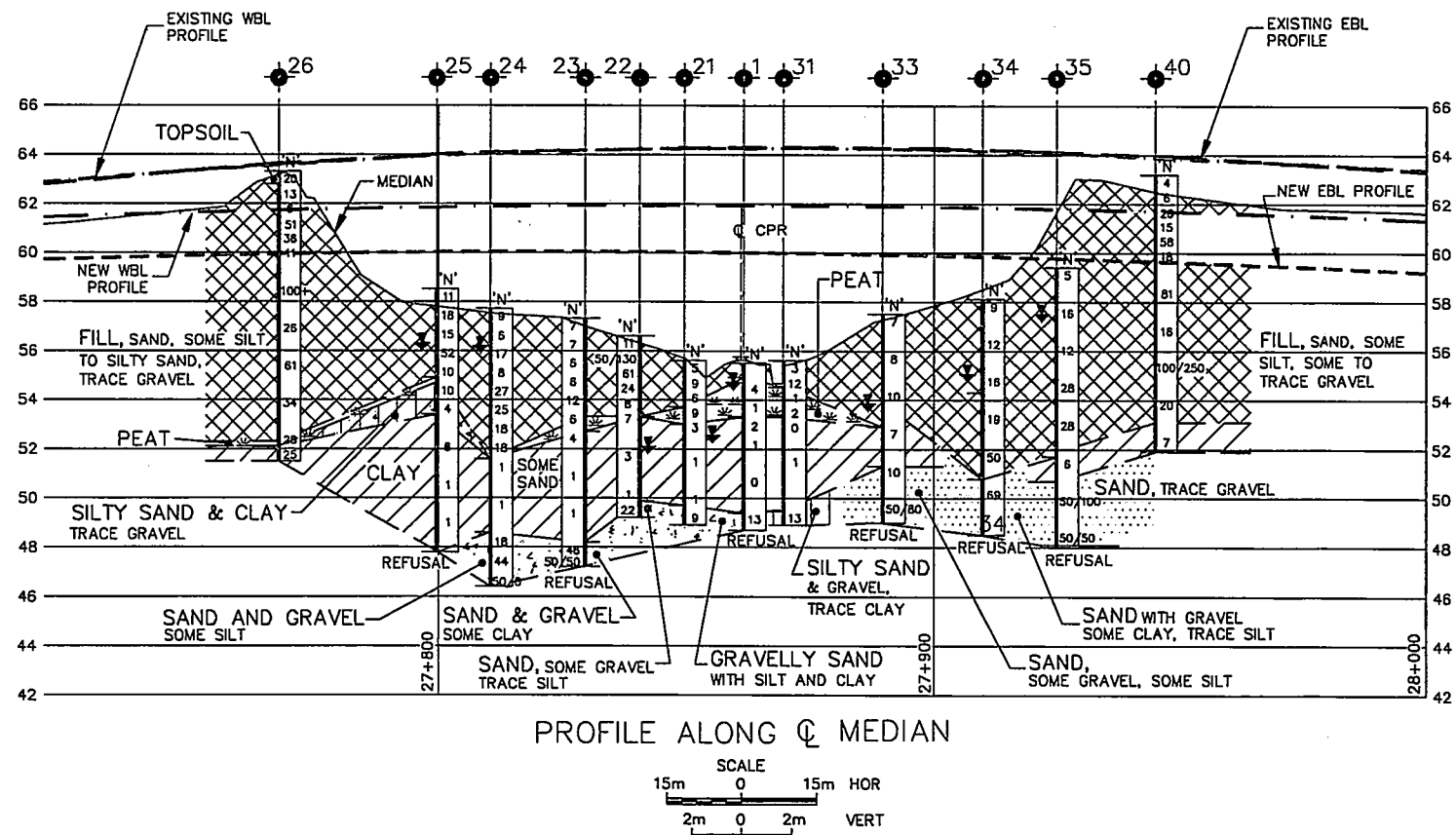
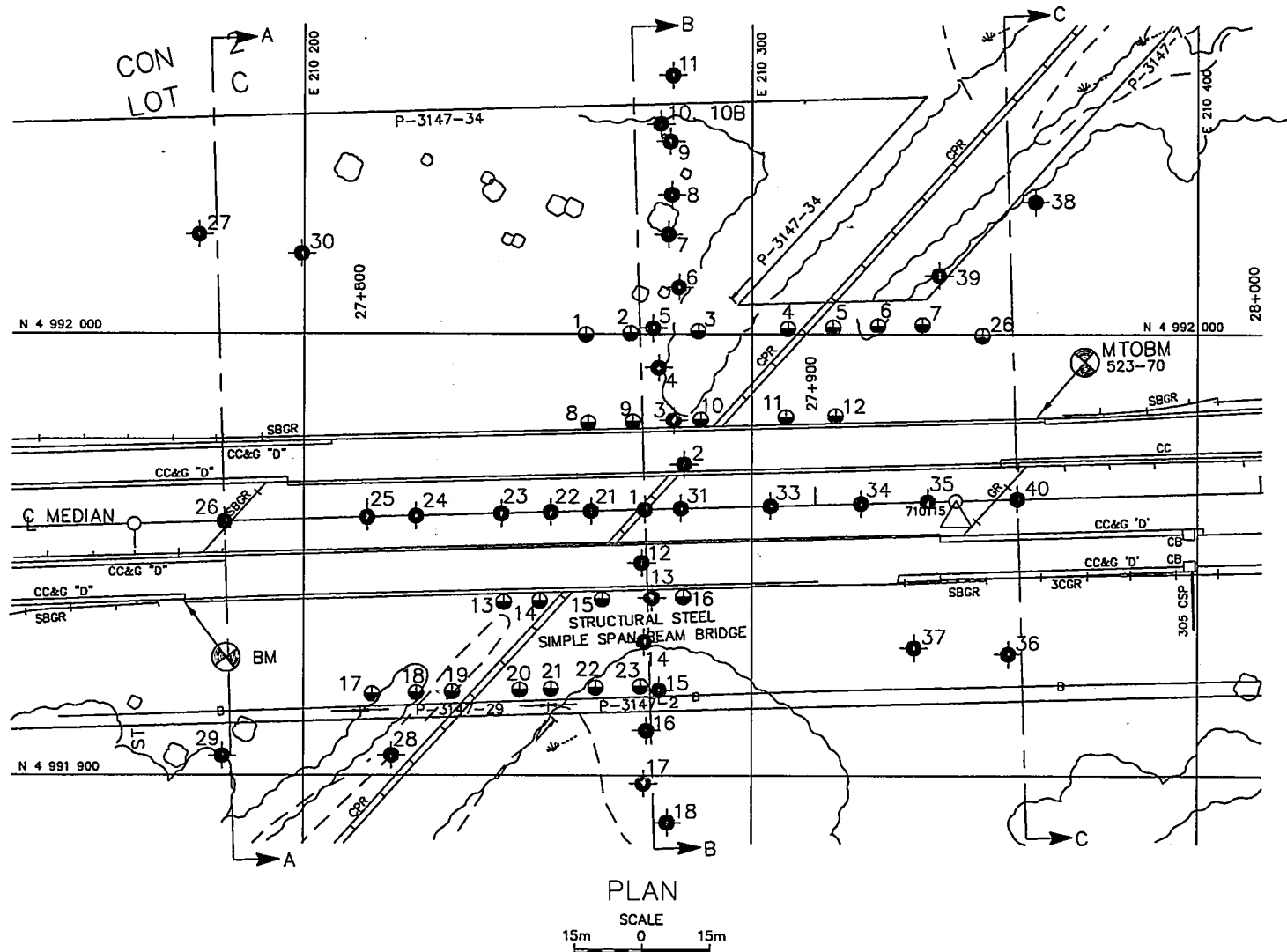
**APPENDIX 2**

**Drawing 11284-FE1 (Key Plan and Borehole Location Plan)**  
**Drawing 11284-FE2 (Stratigraphic Cross Section)**



Environnement Canada / Environment Canada





METRIC  
DIMENSIONS ARE IN METRES  
AND/OR MILLIMETRES  
UNLESS OTHERWISE SHOWN

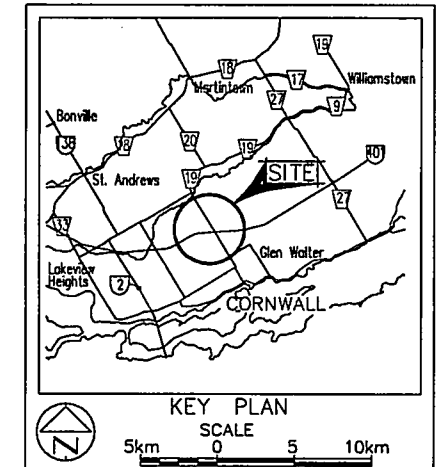
CONT No  
WP No 82-91-00

REMOVAL OF OVERHEAD  
CPR STRUCTURE  
STA 27+764 TO STA 27+951  
BORE HOLE LOCATIONS & SOIL STRATA



SHEET  
1

JACQUES, WHITFORD LIMITED



PROBE HOLES			
No	ELEVATION	COORDINATES NORTH	EAST
1	56.7	4 991 999.9	210 263.0
2	56.4	4 992 000.2	210 273.0
3	55.6	4 992 000.7	210 288.0
4	55.2	4 992 001.3	210 308.0
5	57.1	4 992 001.5	210 318.0
6	57.3	4 992 001.8	210 328.0
7	57.5	4 992 002.1	210 338.0
8	57.6	4 991 979.9	210 263.6
9	57.0	4 991 980.2	210 273.6
10	56.1	4 991 980.7	210 288.6
11	56.5	4 991 981.2	210 307.6
12	56.9	4 991 981.6	210 318.6
13	57.5	4 991 939.4	210 244.8
14	56.1	4 991 939.6	210 252.8
15	55.5	4 991 940.0	210 266.8
16	56.1	4 991 940.5	210 284.8
17	57.6	4 991 918.5	210 215.4
18	57.5	4 991 918.8	210 225.4
19	57.1	4 991 919.0	210 233.4
20	55.3	4 991 919.4	210 248.4
21	55.2	4 991 919.7	210 255.4
22	55.3	4 991 920.0	210 265.4
23	55.8	4 991 920.3	210 275.4
26	-	4 991 999.7	210 351.4

LEGEND	
	Bore Hole
	Dynamic Cone Penetration Test (Cone)
	Bore Hole & Cone
	Probe Hole
'N'	Blows/0.3m (Std Pen Test, 475 J/blow)
CONE	Blows/0.3m (60° Cone, 475 J/blow)
WL	WL at time of investigation 00 01 05

BORE HOLES			
No	ELEVATION	COORDINATES NORTH	EAST
16	55.5	4 991 910.3	210 276.6
17	55.4	4 991 898.3	210 276.0
18	55.4	4 991 889.4	210 281.3
21	55.6	4 991 960.0	210 264.2
22	56.6	4 991 959.7	210 255.2
23	57.3	4 991 959.4	210 244.2
24	57.7	4 991 958.8	210 225.2
25	58.5	4 991 958.5	210 214.2
26	63.3	4 991 957.6	210 182.2
27	56.7	4 992 022.4	210 176.3
28	56.5	4 991 904.6	210 219.8
29	56.9	4 991 904.5	210 181.8
30	55.8	4 992 018.1	210 199.5
31	55.6	4 991 960.5	210 284.2
33	57.5	4 991 961.1	210 304.2
34	58.1	4 991 961.7	210 324.2
35	59.4	4 991 962.1	210 339.2
36	56.2	4 991 927.7	210 357.2
37	55.6	4 991 929.0	210 336.1
38	56.8	4 992 029.9	210 363.2
39	56.6	4 992 013.2	210 341.7
40	63.0	4 991 962.7	210 359.2

BORE HOLES			
No	ELEVATION	COORDINATES NORTH	EAST
1	55.5	4 991 960.3	210 276.2
2	56.4	4 991 970.6	210 284.9
3	55.6	4 991 980.5	210 282.6
4	55.5	4 991 992.4	210 279.3
5	56.0	4 992 001.4	210 278.0
6	55.3	4 992 010.5	210 283.7
7	55.7	4 992 022.5	210 281.4
8	55.9	4 992 031.5	210 282.1
9	55.9	4 992 043.5	210 281.8
10	55.7	4 992 047.4	210 279.6
10B	55.7	4 992 047.4	210 279.6
11	55.2	4 992 058.5	210 282.3
12	55.5	4 991 948.3	210 275.5
13	55.5	4 991 940.3	210 277.8
14	55.3	4 991 930.3	210 276.1
15	55.5	4 991 919.4	210 279.4

NOTE

The boundaries between soil strata have been established only at Bore Hole locations. Between Bore holes the boundaries are assumed from geological evidence.

NOTE: The complete foundation investigation and design report for this project and other related documents may be examined at the Engineering Materials Office, Downview. Information contained in this report and related documents is specifically excluded in accordance with the conditions of Section 102-2 of Form 100.

REV.	DATE	BY	DESCRIPTION
1			
GEOCRES No			
HWY No 401			DIST 41
SUB'D FG	CHECKED	DATE 2001-02-14	SITE
DRAWN GBB	CHECKED	APPROVED	DWG 11284-FE1

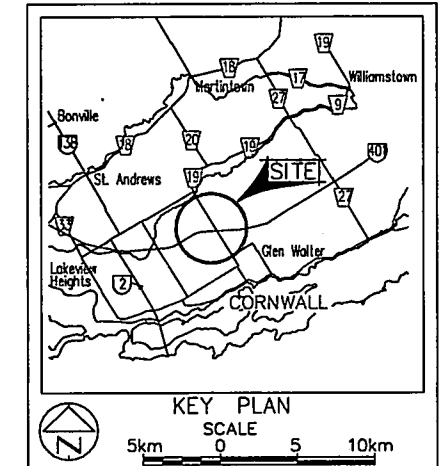
METRIC  
DIMENSIONS ARE IN METRES  
AND/OR MILLIMETRES  
UNLESS OTHERWISE SHOWN

CONT	No	
WP	No	82-91-00






REMOVAL OF OVERHEAD  
CPR STRUCTURE  
STA 27+764 TO STA 27+951  
SOIL STRATA

SHEET  
2

JACQUES, WHITFORD LIMITED



### LEGEND

- |   |                                       |
|---|---------------------------------------|
|  | Bore Hole                             |
|  | Dynamic Cone Penetration Test (Cone)  |
|  | Bore Hole & Cone                      |
|  | Probe Hole                            |
| 'N'   | Blows/0.3m (Std Pen Test, 475 J/blow) |
| CONE  | Blows/0.3m (60° Cone, 475 J/blow)     |
|  | WL at time of investigation 00 01 05  |

## BORE HOLES

No	ELEVATION	COORDINATES	
		NORTH	EAST

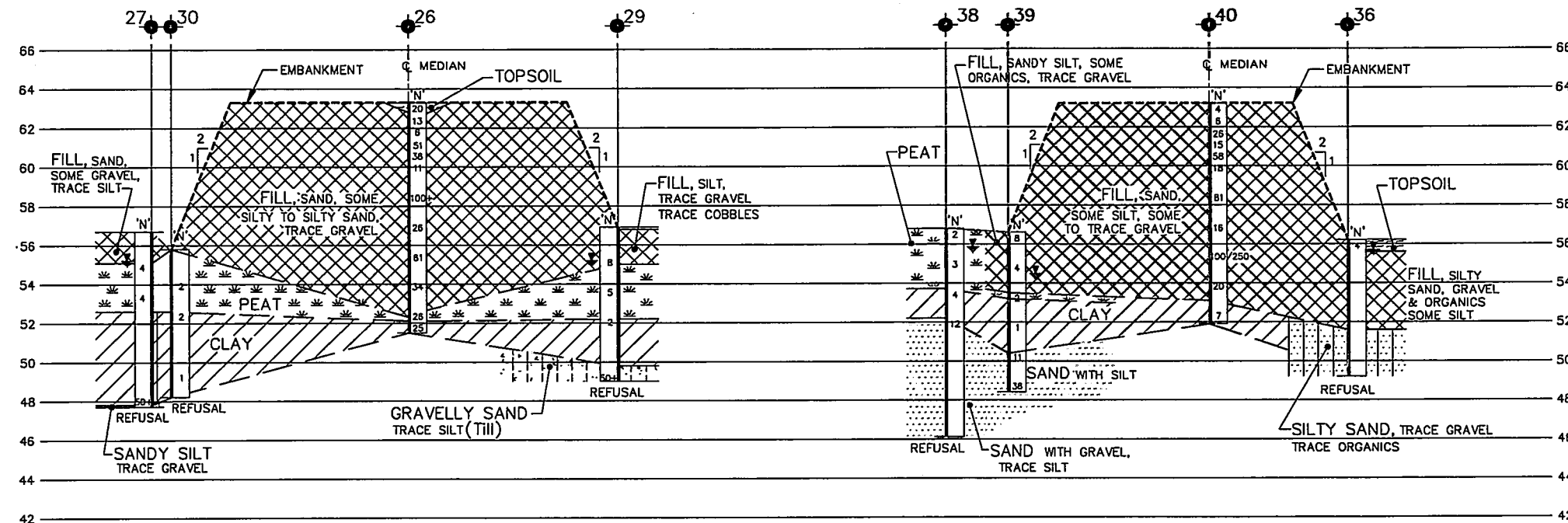
= NOTE =

The boundaries between soil strata have been established only at Bore Hole locations. Between Bore holes the boundaries are assumed from geological evidence.

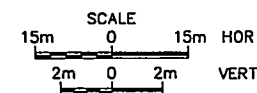
NOTE: The complete foundation investigation and design report for this project and other related documents may be examined at the Engineering Materials Office, Downsview. Information contained in this report and related documents is specifically excluded in accordance with the conditions of Section 102-2 of Form 100.

Rev.	-	-	-
	DATE	BY	DESCRIPTION

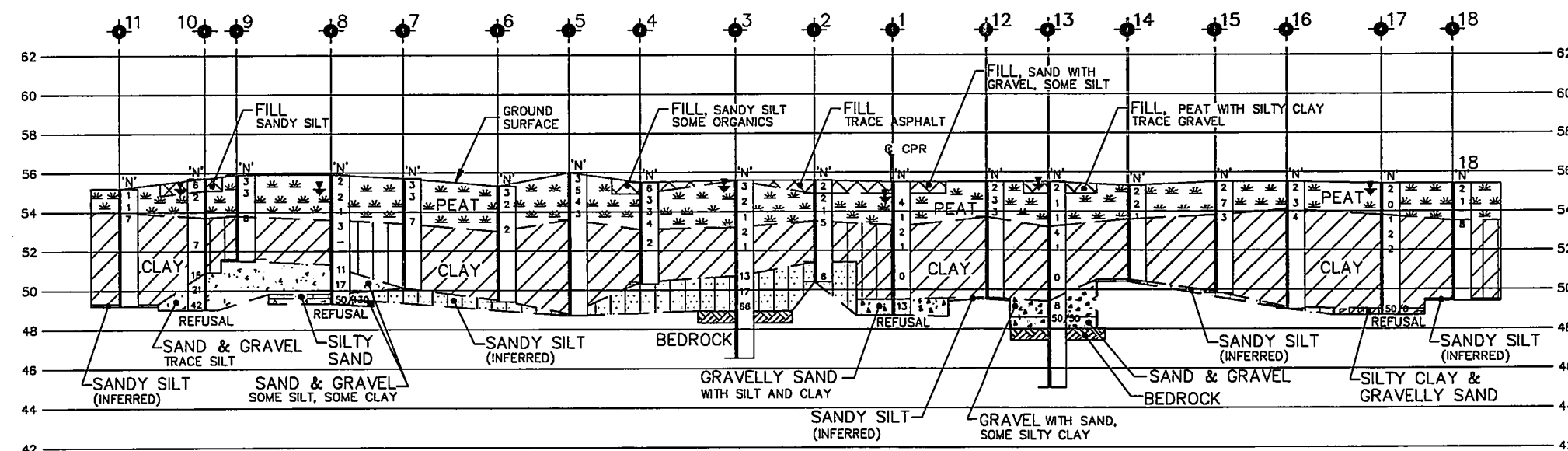
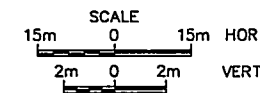
GEOGRES No				
HWY No 401			DIST 41	
SUBM'D	FG	CHECKED	DATE 2001-02-14	SITE
DRAWN	GBB	CHECKED	APPROVED <i>JM</i>	DWG 11284--FE2



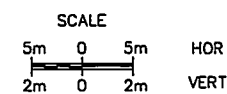
SECTION A - A



SECTION C - C



SECTION B - B



### **APPENDIX 3**

**Figure 7 Settlement Along WBL**

**Figure 8 – Settlement at Sta. 27+850**

**Figure 9 – Settlement/Time Curves**

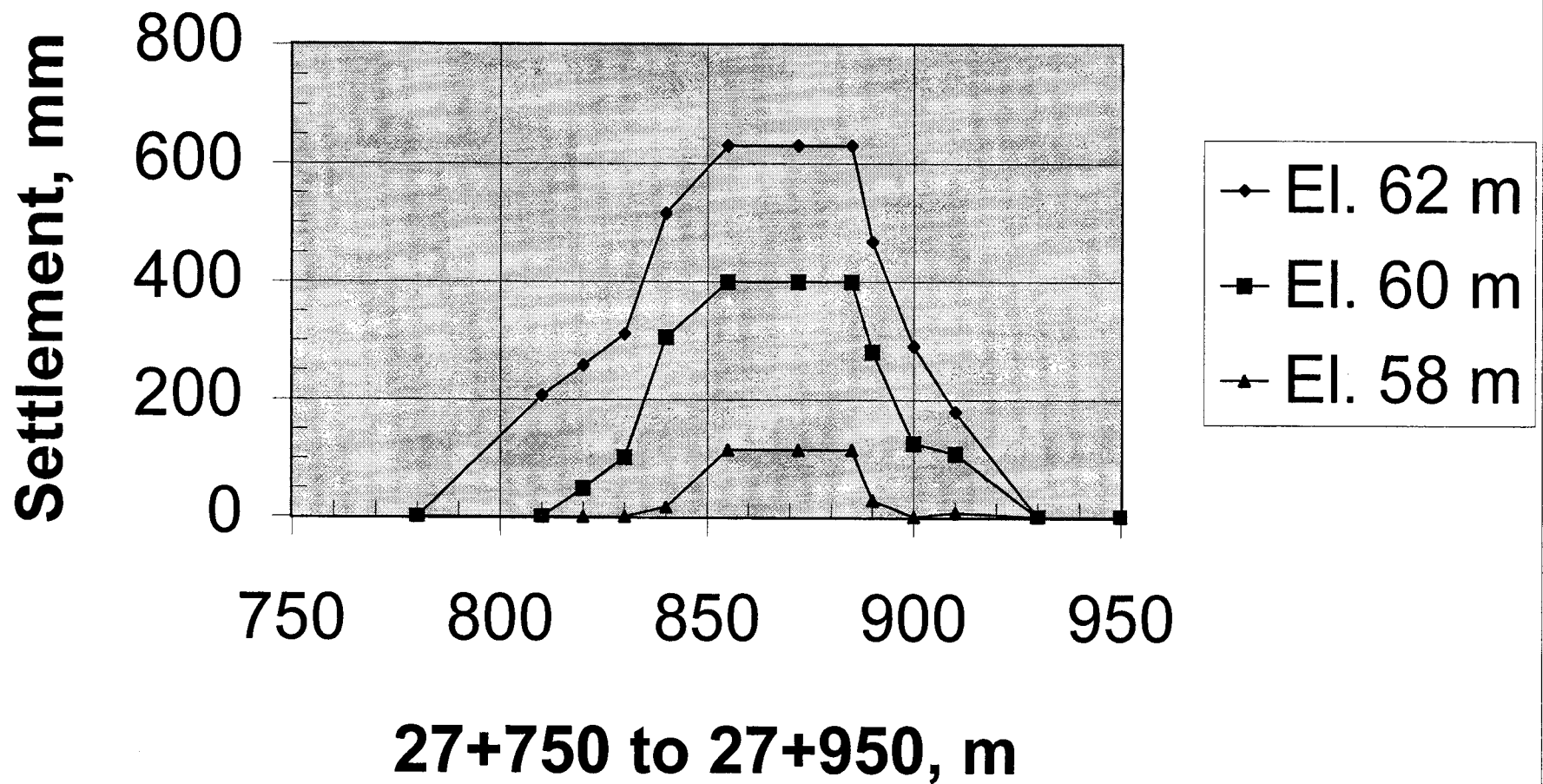
**Figure 10 – Settlement/Time Curve, Pile Cap Effect**



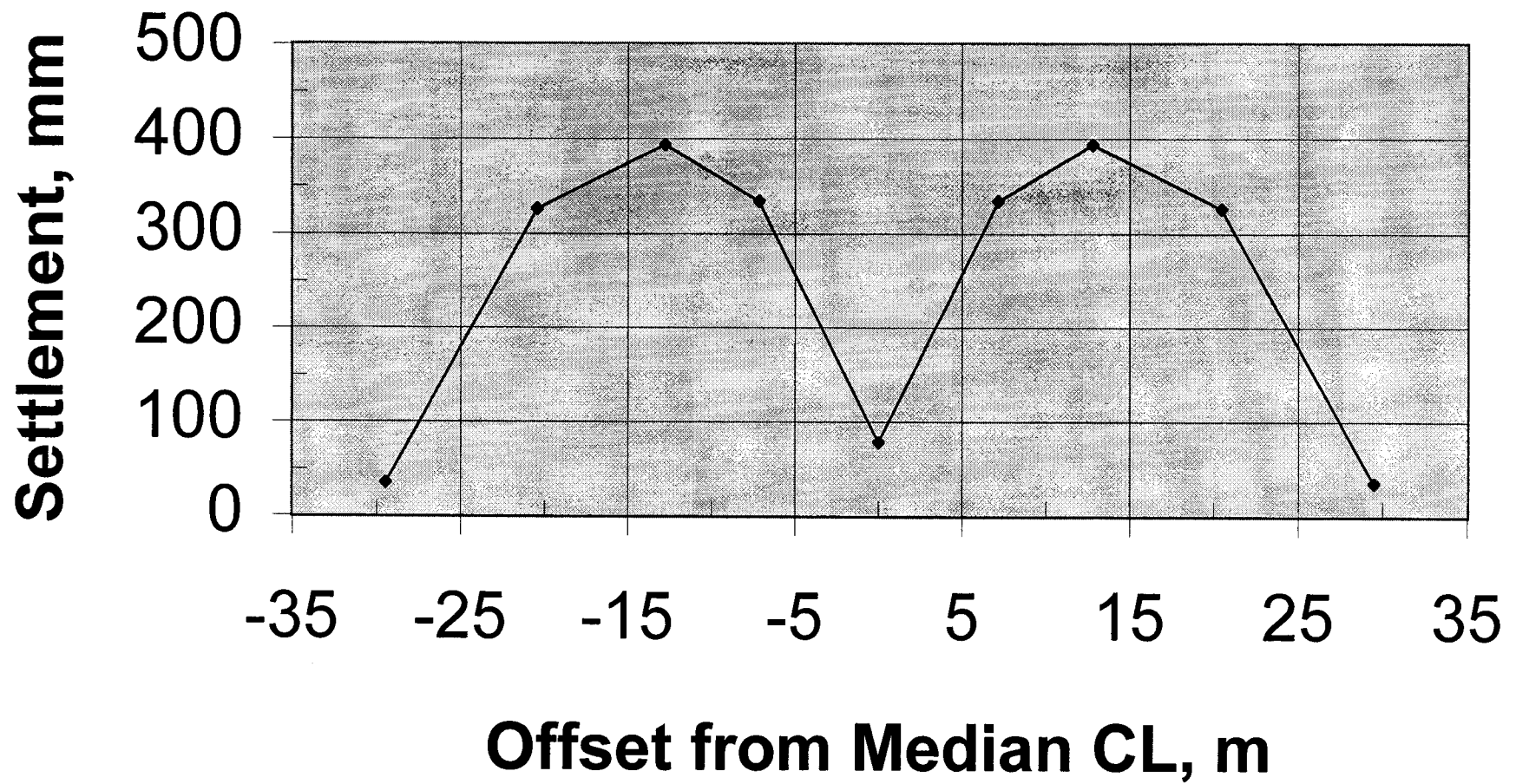
Environment Canada  
Environnement Canada



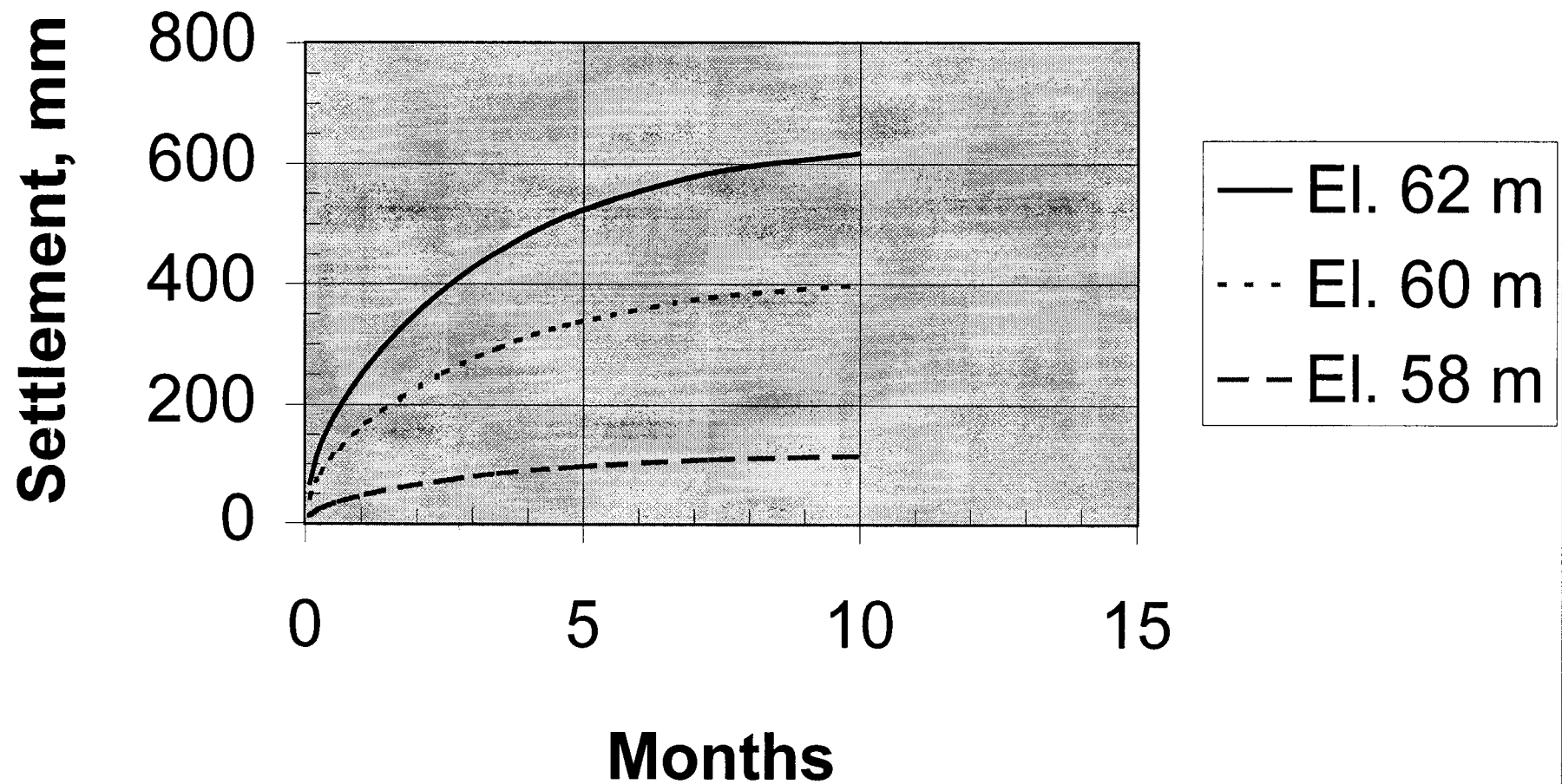
# Settlement along WBL



## Settlement at 27+850

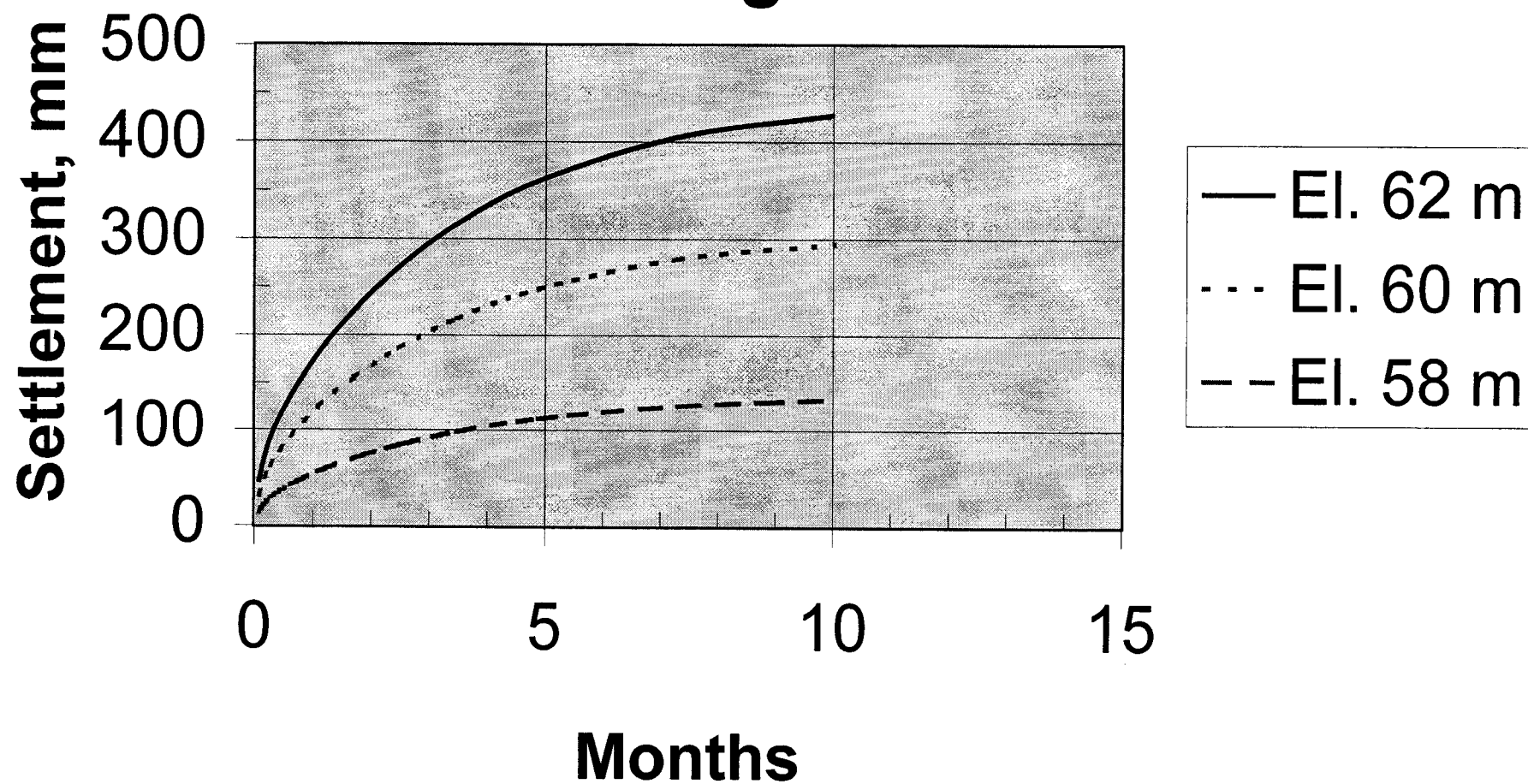


# Time Rate of Settlement Conventional Fill

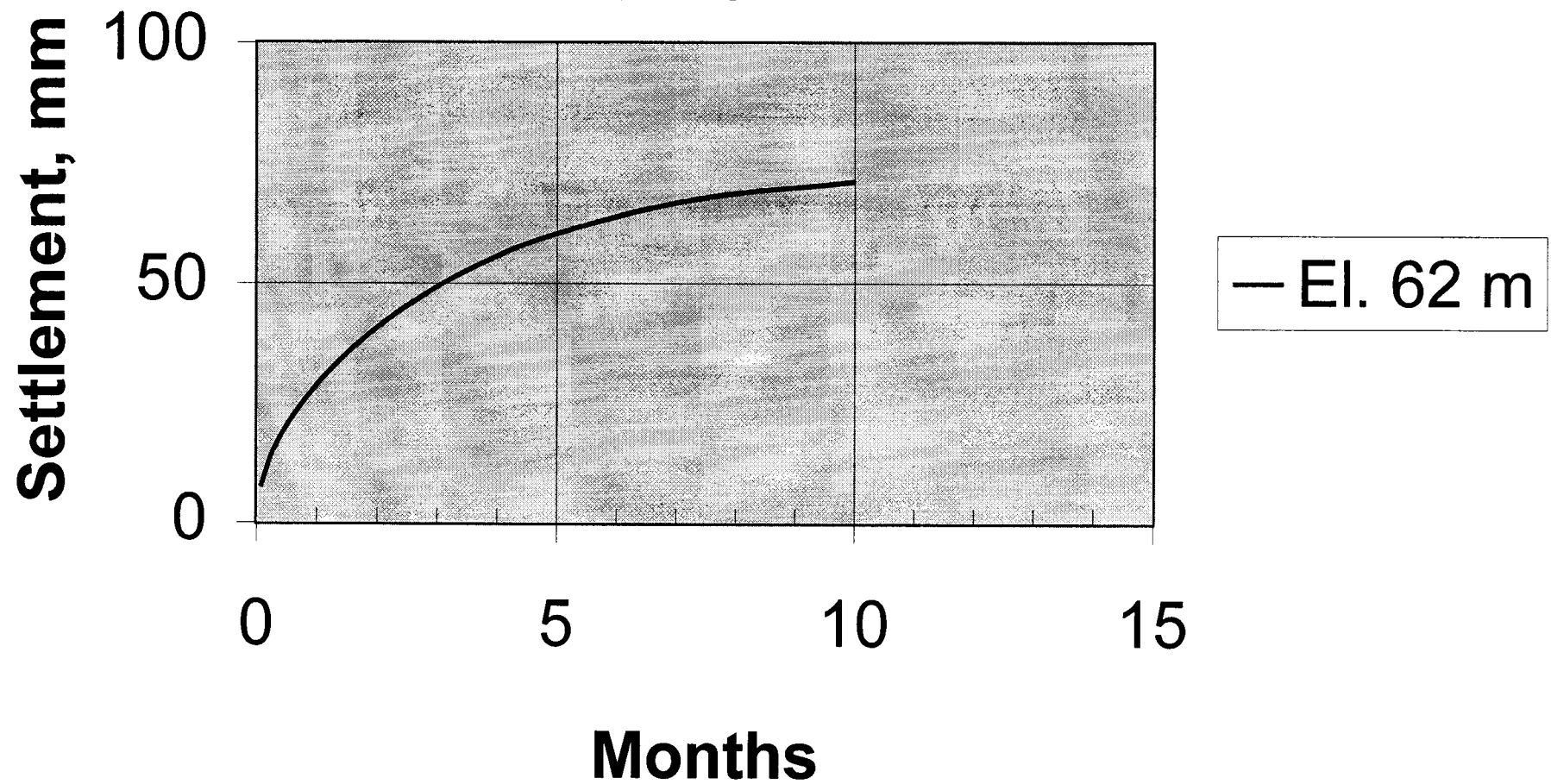




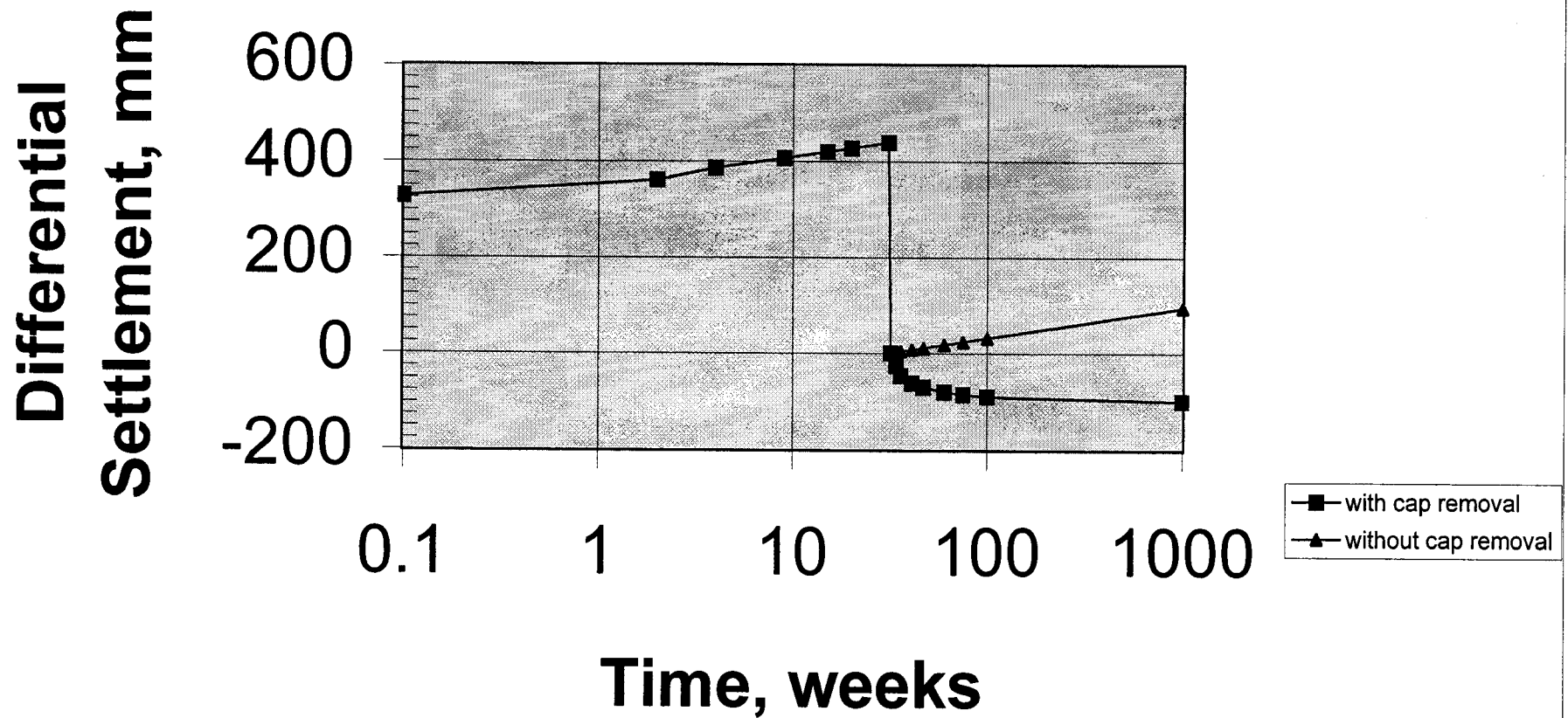
# Time Rate of Settlement Slag Fill



# Time Rate of Settlement Polystyrene Fill



# Time Rate of Settlement Pile Cap Effect



## **APPENDIX 4**

**Drawing 11284-FE3 (Peat Removal Limits)**

**Drawing 11284-FE4 (Wick Drain Limits and Spacing)**

**Drawing 11284-FE5 (Culvert Backfill)**

**Drawing 11284-FE6 (Pile Cap Backfill)**



Environment Canada  
Environnement Canada

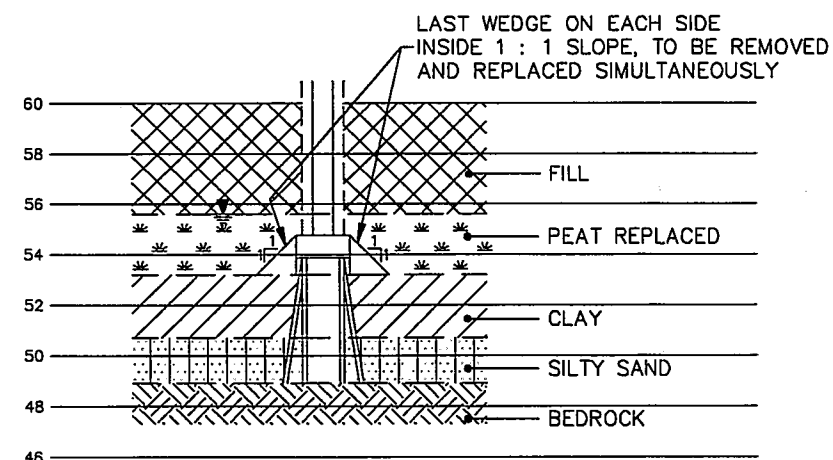
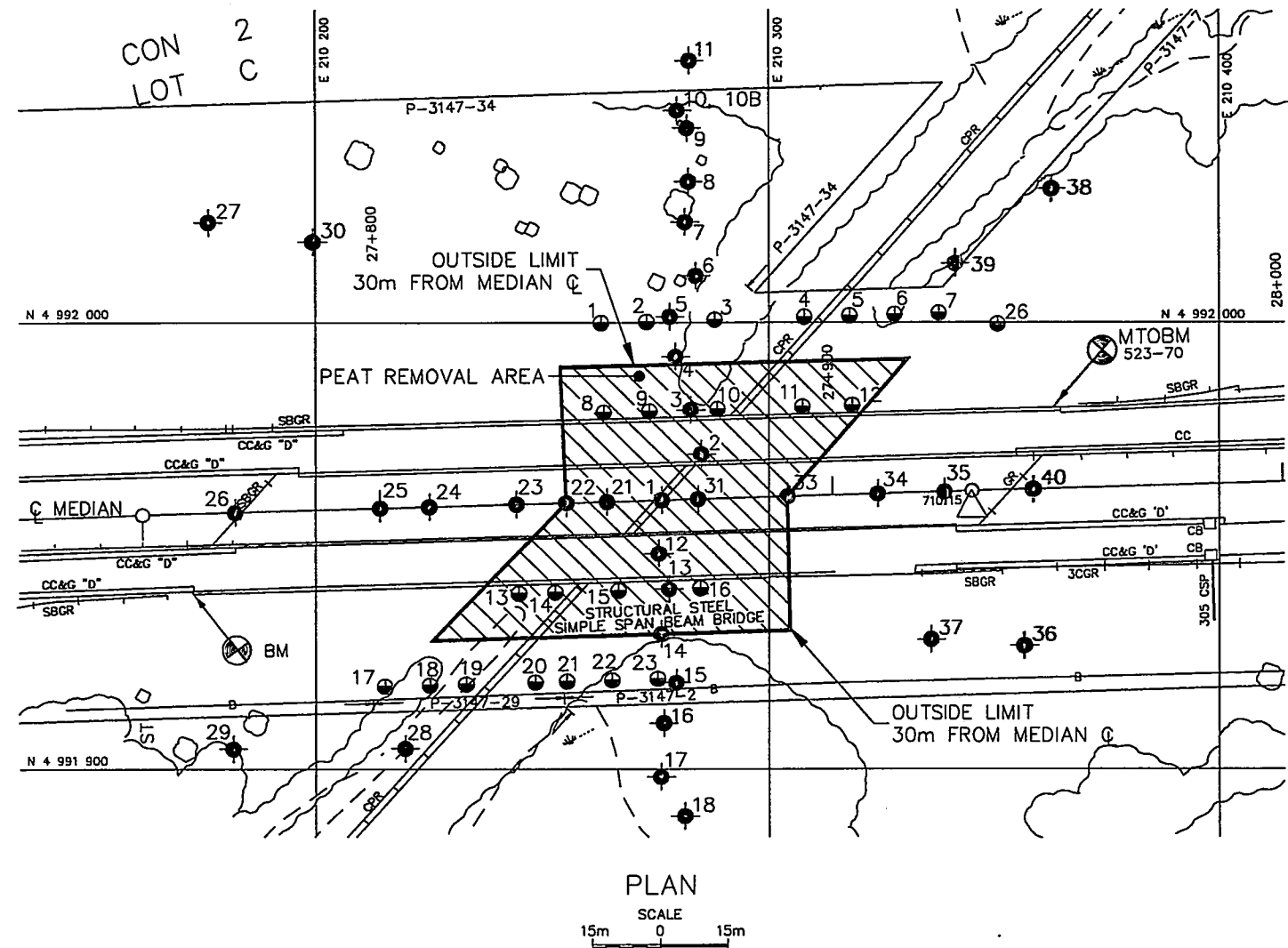
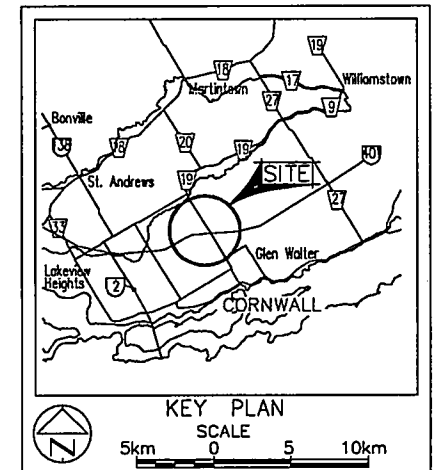


METRIC  
DIMENSIONS ARE IN METRES  
AND/OR MILLIMETRES  
UNLESS OTHERWISE SHOWN

CONT No  
WP No 82-91-00

# REMOVAL OF OVERHEAD CPR STRUCTURE STA 27+764 TO STA 27+951 PEAT REMOVAL LIMITS

JACQUES, WHITFORD LIMITED



TYPICAL DETAIL

SCALE

2m 0 2m


≡ NOTE ≡

The boundaries between soil strata have been established only at Bore Hole locations. Between Bore holes the boundaries are assumed from geological evidence.

NOTE: The complete foundation investigation and design report for this project and other related documents may be examined at the Engineering Materials Office, Downsview. Information contained in this report and related documents is specifically excluded in accordance with the conditions of Section 102-2 of Form 100.

Rev.	-	-	-
	DATE	BY	DESCRIPTION

GEOCRES No

HWY No 401			DIST 41	
SUBM'D	FG	CHECKED	DATE 2001-02-14	SITE
DRAWN	G88	CHECKED	APPROVED 	DWG 11284-FE3

METRIC  
DIMENSIONS ARE IN METRES  
AND/OR MILLIMETRES  
UNLESS OTHERWISE SHOWN

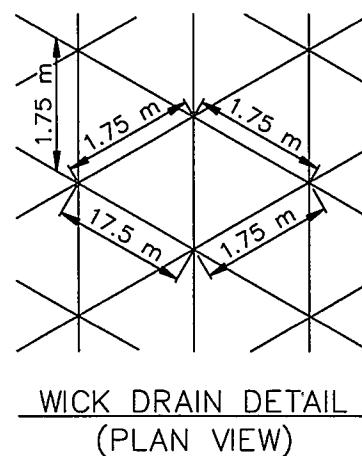
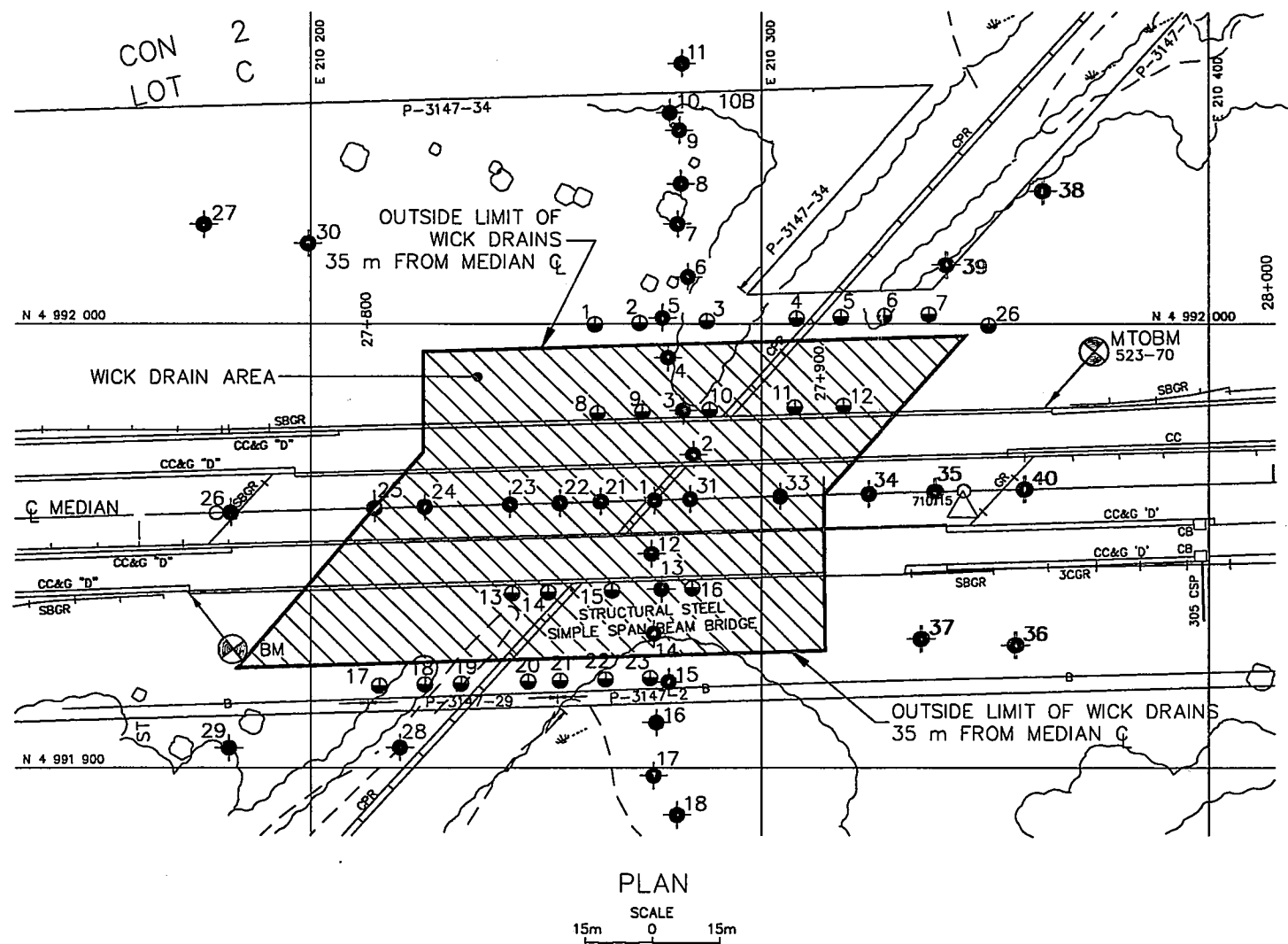
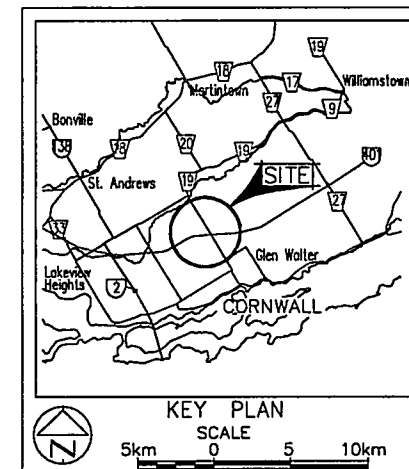
CONT No  
WP No 82-91-00

REMOVAL OF OVERHEAD  
CPR STRUCTURE  
STA 27+764 TO STA 27+951  
WICK DRAIN LIMITS



SHEET  
1

JACQUES, WHITFORD LIMITED



#### WICK DRAIN LIMITS

C MEDIAN 27+800 TO 27+900  
C WBL 27+810 TO 27+915  
C EBL 27+785 TO 27+900

#### NOTE

The boundaries between soil strata have been established only at Bore Hole locations. Between Bore holes the boundaries are assumed from geological evidence.

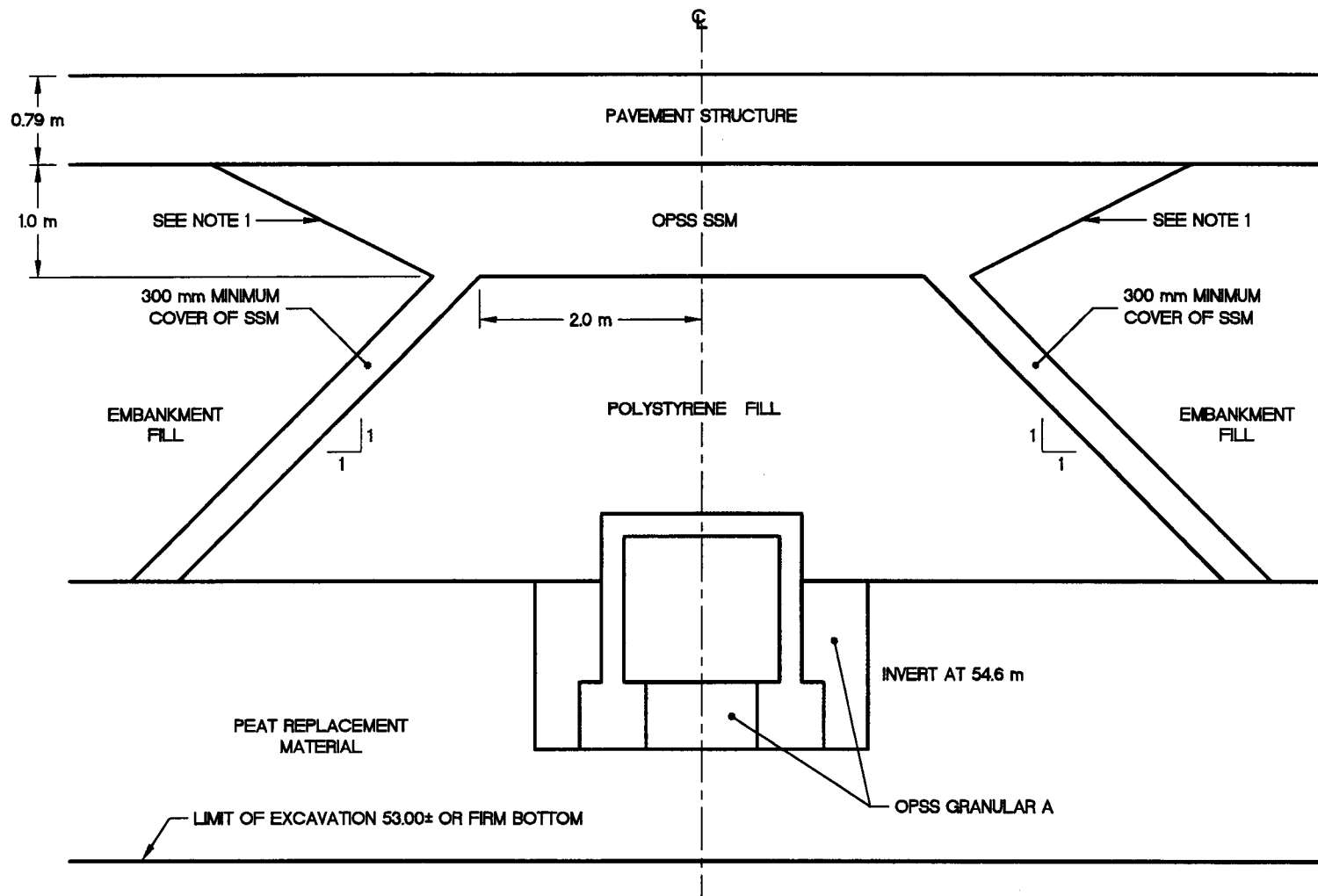
NOTE: The complete foundation investigation and design report for this project and other related documents may be examined at the Engineering Materials Office, Downsview. Information contained in this report and related documents is specifically excluded in accordance with the conditions of Section 102-2 of Form 100.

Rev.	DATE	BY	DESCRIPTION
1			

GEOCRES No

HWY No 401	DIST 41
SUBM'D FG CHECKED	DATE 2001-02-14 SITE
DRAWN GBB CHECKED	APPROVED DWG 11284-FE4

# CULVERT BACKFILL DETAIL



## NOTES:

1. TAPER AS PER OPSD 205.04, t=1.5 m
2. TO BE READ IN CONJUNCTION WITH OPSD 803.010.
3. TOP AND SIDE SURFACES OF THE POLYSTYRENE COVERED WITH 10 MIL POLYETHYLENE SHEETING. ALL JOINTS LAPPED 300 mm.

MINISTRY OF TRANSPORTATION OF ONTARIO  
WP 82-91-00  
Highway 401/CPR Overhead Structure Removal

CORNWALL

ONTARIO

Scale:

N.T.S.

Drawing No.:

11284-FE5

Date:

01/02/14

Dwn. by:

GBB

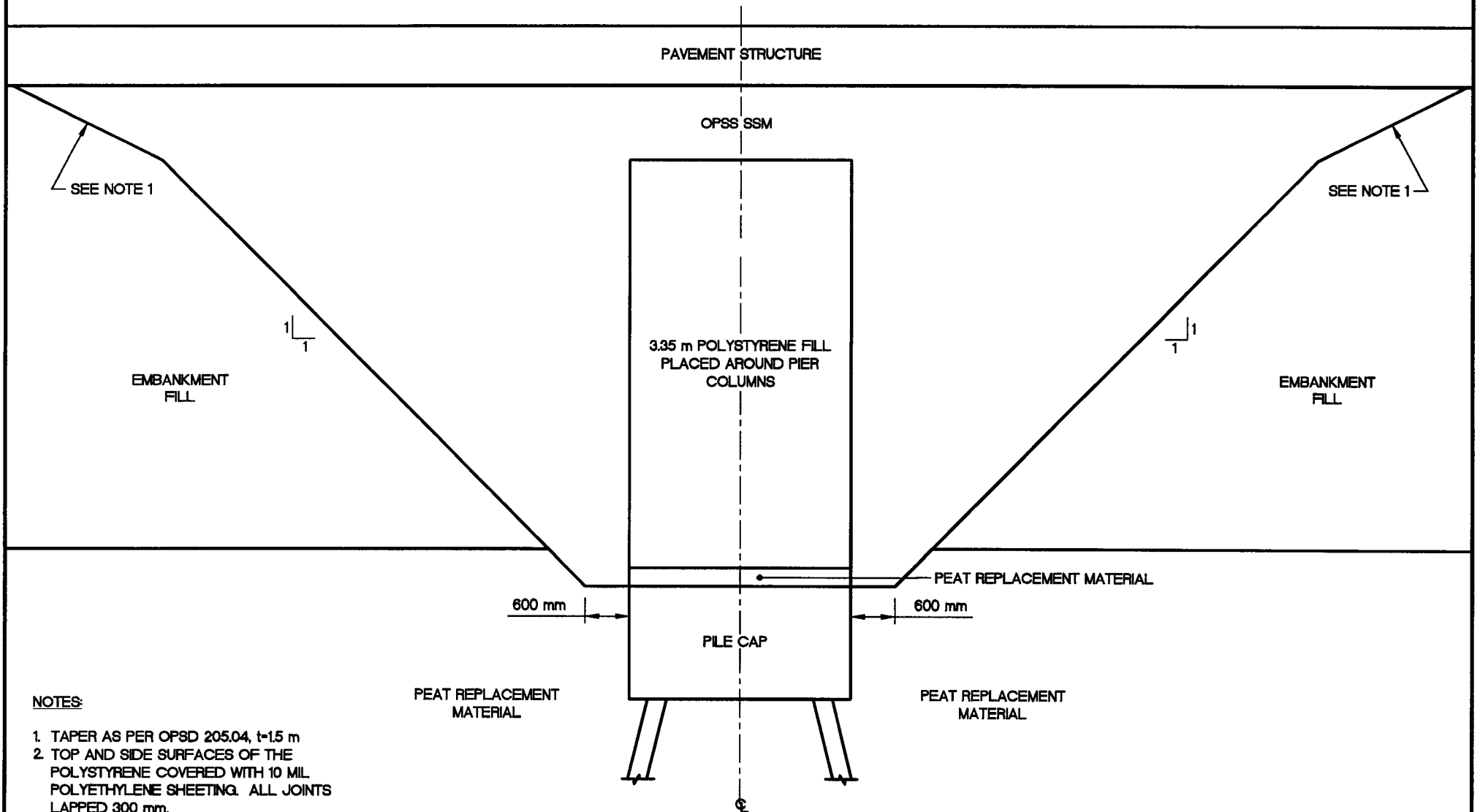
Appd.:

720



Jacques  
Whitford

# PIER BACKFILL DETAIL WEST BOUND PIERS C, D, AND E EAST BOUND PIERS D AND E



## NOTES:

1. TAPER AS PER OPSD 205.04, t=1.5 m
2. TOP AND SIDE SURFACES OF THE POLYSTYRENE COVERED WITH 10 MIL. POLYETHYLENE SHEETING. ALL JOINTS LAPPED 300 mm.

MINISTRY OF TRANSPORTATION OF ONTARIO  
 WP 82-91-00  
 Highway 401/CPR Overhead Structure Removal

CORNWALL,

ONTARIO

Scale:

N.T.S.

Drawing No.:

11284-FE6

Date:

01/02/14

Dwn. by:

GBB

Appd.:

725



Jacques  
Whitford



**APPENDIX 5**

**SPECIAL PROVISIONS**

**Light Weight Fill  
Wick Drains**



Ecologo Paper Paper Ecologo



## **RIGID EXPANDED POLYSTYRENE - EMBANKMENT FILL**

### Special Provision

#### **1. SCOPE**

This specification covers the requirements for the supply and construction of the rigid expanded polystyrene embankment fill as shown on the contract drawings.

#### **2. REFERENCES**

This specification refers to the following standards, specifications or publications.

##### National Standards of Canada

CAN/CGSB - 51.20 M87

##### ASTM

ASTM D1621	Test Method for Compressive Properties of Rigid Cellular Plastics
ASTM C203	Test Method for Breaking Load and Flexural Properties of Block Type Thermal Insulation
ASTM C177	Test Method for Steady State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus
ASTM C518	Test Method for Steady State Heat Flux Measurements and Thermal Transmission Properties by Means of the Heat Flow Apparatus
ASTM D2842	Test Method for Water Absorption By Rigid Cellular Plastics
ASTM D2863	Test Method for Measuring the Minimum Oxygen Content

ASTM D2126 Test Method for Response of Rigid Cellular Plastics to Thermal and Humid Aging

OPSS - Ontario Provincial Standard Specification

OPSS 212	Borrow
OPSS 501	Compaction
OPSS 517	Dewatering
OPSS 1010	Aggregates - Granular A,B,M and Selected Subgrade Material
OPSS 1605	Expanded Extruded Polystyrene Pavement Insulation
OPSS 1860	Geotextiles

**3 SUBSURFACE CONDITIONS**

The subsurface conditions at the site are described in the Foundation Investigation Report for this Contract.

**4. DEFINITIONS**

For the purpose of this specification, the following definitions apply:

**Rigid Expanded Polystyrene**

Moulded rigid blocks produced by a process of preexpansion, aging and forming of a petroleum based raw material.

**Rigid Extruded Expanded Polystyrene**

Rigid boards made by extrusion of expanded polystyrene beads.

**Production Lot**

The quantity of rigid polystyrene blocks produced in a continuous period of manufacturing the same grade and thickness of product within the same production day.



- e) The method of placement of 710 mm of OPSS SSM.
- f) The method of placement of subbase material.
- g) The method of placement of side slope cover.

## 7. MATERIALS

### 7.1 Granular Levelling Pad

The levelling pad shall consist of a granular 'A' or Granular 'B' material with gradation and physical requirements as specified in OPSS 1010.

### 7.2 Rigid Expanded Polystyrene

#### 7.2.1 General

##### 7.2.1.1 The Contractor shall submit:

1. A general statement as to the type, composition and method of production of the material.
2. The manufacturer's name, address, phone number, identification of a contact person and description of experience background in the manufacturing of the rigid expanded polystyrene
3. Certification of compliance of physical and mechanical properties.
4. An identification of a laboratory accredited by the Standards Council of Canada to conduct the testing of the physical and mechanical properties of the rigid expanded polystyrene.

5. The physical and mechanical properties of the rigid expanded polystyrene including

1. Geometry
2. Nominal Density
3. Compressive Strength
4. Flexural Strength
5. Thermal Resistance
6. Dimensional Stability
7. Flammability
8. Water Absorption

6. Aging and durability characteristics of the polystyrene including the chemical, biological and ultra-violet degradation resistance of the rigid polystyrene.

7.2.1.2 Each block of the same production lot shall be stamped with the same production code showing plant identification, type and date of production. The polystyrene shall be free from defects affecting serviceability.

7.2.2 Detail Requirements

Requirements shall be as shown in Table 1 and as described below.

TABLE 1 - MATERIAL PROPERTIES



PROPERTY	UNIT	REQUIREMENTS	TEST PROCEDURE
Geometry	(mm)	1200x600x300 with tolerances ±1% 10 mm in 3 m ±0.5% -3, +5	
- Linear - Flatness - Squareness - Thickness			
Compressive Strength	kPa (min)	110	ASTM D1621 (Procedure A)
Flexural Strength	kPa (min)	240	ASTM C203
Dimensional Stability	% linear change(max)	1.5	ASTM D2126
Thermal Resistance	m <sup>2</sup> .°C/W (min for 25 mm thickness)	0.7	ASTM C177 or C518
Flammability	Limiting Oxygen Index(min)	24	ASTM D2863
Water Absorption	% by Volume (max)	4	ASTM D2842

#### 7.2.2.1 Geometry

The expanded polystyrene shall be supplied in the form of rectangular parallel blocks of minimum acceptable dimensions of 1200 mm x 600 mm x 300 mm.

The maximum deviation from the specified linear dimensions shall be ± 1%.

The flatness of the block faces shall be within  $\pm 10$  mm of a line formed by a 3 m straight edge.

The maximum difference in corner to corner dimensions (squareness) shall be 0.5%.

The thickness shall be within -3 to +5 mm.

#### 7.2.2.1 *Compressive Strength*

The minimum compressive strength, measured in accordance with ASTM D1621, Procedure A, shall be 110 kPa at a strain of not more than 5%. The maximum permissible permanent stress level should not exceed 30% of the compressive strength of the material at 5% strain.

#### 7.2.2.2 *Flexural Strength*

The minimum flexural strength of the polystyrene shall be 240 kPa. The flexural strength shall be determined in accordance to ASTM C 203, Method 1, Procedure B.7.2.4 Dimensional Stability

#### 7.2.2.3 *Dimensional Stability*

Dimensional stability shall be determined in accordance with ASTM D2126, Procedure G. A tolerance of 1.5% shall be satisfied.

#### 7.2.2.4 *Thermal Resistance*

The thermal resistance shall be  $0.7 \frac{\text{m}^2 \cdot ^\circ\text{C}}{\text{W}}$  for a 25 mm thickness using the following equation and using the average value from three specimens

$$R_{25\text{mm}} = \frac{R_{\text{measured}}}{\text{thickness(mm)}} \times 25$$

The thermal resistance shall be measured in accordance with ASTM C177 or C518.

#### 7.2.2.5 *Flammability*

The expanded polystyrene shall be classified as to surface burning characteristics in accordance with CAN4-51022 having a flame spread rating less than 500. The expanded polystyrene shall have a minimum limiting oxygen index measured in accordance with ASTM D2863 of 24.



#### 7.2.2.6 *Water Absorption*

The water absorption as measured by ASTM D2842 shall be limited to 4% by volume.

#### 7.2.2.7 *Chemical Resistance*

The expanded polystyrene shall be resistant to common inorganic acids and alkalies. A table identifying the chemical resistance as either resistant, limited or not resistant shall be submitted.

#### 7.2.2.8 *Biological Resistance*

The expanded polystyrene shall be resistant to biological degradation caused by organisms or enzymes.

#### 7.2.2.9 *Environmental*

The expanded polystyrene shall be inert, non-nutritive and highly stable and shall not produce undesirable gases or leachate.

### 8.0 DELIVERY, STORAGE AND HANDLING

The product shall be suitably marked to identify its type, number and the manufacturers name or trademark.

The Contractor shall protect the expanded polystyrene from exposure to sunlight to avoid ultraviolet degradation as per manufacturer's recommendation.

Protection of materials and works from damage by weather, traffic, fire or vandalism and other causes shall be the responsibility of the Contractor.

### 9.0 CONSTRUCTION

#### 9.1 Foundation Excavation

Foundation excavation shall be carried out to the design elevations shown on the drawings. Any softened, loosened or deleterious materials at the foundation footing elevation shall be subexcavated and replaced with granular 'A' or Granular 'B' material.



## 9.2 Levelling Pad

Place, level and compact a 200 mm thick layer of granular 'A' or Granular 'B' material in accordance with OPSS 501 to within  $\pm 30$  mm of the design elevation. The levelling pad shall not deviate by more than 10 mm at any place on a 3 m straight edge over the limits of the bottom course of blocks. The levelling pad shall not be placed on frozen ground.

## 9.3 Installation of Blocks

- (1) The individually marked blocks shall be placed on the prepared levelling pad. The top surface of the first layer of blocks is to be set plane and level. Local trimming of the blocks may be necessary.
- (2) Subsequent successive layers shall be oriented with the long axis of blocks positioned at  $90^\circ$  to the previous layer in order to avoid continuous joints. Block joints shall be offset and staggered between layers.

A continuous check shall be kept to ensure the evenness of the blocks are satisfactory in each layer. Blocks shall be laid with joints with maximum opening of 10 mm between blocks. Differences in heights between adjacent blocks in the same layer should not exceed 5mm.

- (3) Sloping end adjustments at the abutments shall be accomplished by levelling terraces in the subsoil in accordance with the block thickness.
- (4) Temporary ballast shall be provided as necessary to prevent movement of expanded polystyrene both in storage and as placed due to windy conditions. Timber fasteners or equivalent shall be used as necessary.
- (5) The expanded polystyrene embankment shall be protected from accidental ignition due to welding, smoking, grinding or cutting tools, etc. The Contractor shall take all necessary precautions to prevent ignition of the expanded polystyrene.
- (6) The expanded polystyrene shall be protected from organic solvents and other aggressive, harmful chemicals during construction. The proposed method of protection during construction shall be submitted to the Contract Administrator.



- (7) Exposed blocks shall be covered immediately to avoid possible burrowing by animals.
- (8) Individually marked blocks shall be fabricated and placed to ensure the top surface matches the elevation and crossfall shown on the drawings.
- (9) The top surface and side surfaces of the expanded polystyrene shall be covered with 10 mil polyethylene sheeting extending onto adjacent work at the longitudinal ends of the embankment. All joints shall be lapped a minimum of 300mm to provide a fully sealed enclosure.
- (8) The side slope of the rigid expanded polystyrene embankment shall be covered with a minimum thickness of 300 mm of selected subgrade material with maximum size of 4.75 mm. The selected subgrade material shall be compacted to achieve 90% standard proctor density. Topsoil shall be placed in sequence as shown on the contract drawings.

## 10. EQUIPMENT

All cutting of polystyrene materials shall be by electric equipment or by hand.

Heavy equipment shall be limited in weight and size and restricted in operation to avoid damaging the expanded polystyrene as per the manufacturer's requirement.

## 11. QUALITY ASSURANCE

### 11.1 Certificate of Compliance

Quality test certificates for each production lot supplied, showing compliance with all requirements of this specification, shall be obtained by the Contractor and submitted to the Contract Administrator prior to installation.

## 11.2 Sampling and Testing

### 11.2.1 *General*

The Contract Administrator may undertake an independent testing program of the expanded polystyrene. Sampling and testing will be carried out in conformance with the relevant test procedure. The physical and thermal property testing identified in Table 1 will be conducted. The testing shall be conducted by a recognized testing laboratory accredited by the Standards Council of Canada.

### 11.2.2 Sampling Frequency

Sufficient sample material shall be obtained from blocks randomly selected by the Contract Administrator from each production lot as soon as the material arrives on site. As a minimum, three blocks shall be tested.

### 11.2.3 *Acceptance/Rejection*

Failure of any one of the sample blocks to comply with any requirements of this specification shall be cause for rejection of the production lot from which it was taken. Replacement of the blocks shall be at the Contractor's expense.

## 12. PAYMENT

### 12.1 Measurement for Payment

Measurement for the supply and installation of the rigid expanded polystyrene embankment shall be on a per cubic metre basis.

### 12.2 Basis of Payment

Foundation Excavation and Preparation - Item  
 Granular Levelling Pad - Item  
 Rigid Expanded Polystyrene - Item  
 Polyethylene Sheeting - Item  
 Side Cover Material - Item

Payment at the contract price for the above tender items shall be full compensation for all labour, materials and equipment to do the work.



## **WICK DRAINS - Item No.**

---

Special Provision

March 2000

---

### **1.0 GENERAL**

#### **1.1 Scope**

This non-standard special provision specifies the requirements for the supply and installation of wick drains in accordance with the details shown elsewhere in the contract, and with the requirements of these specifications.

#### **1.2 Qualifications**

This work shall be undertaken by a recognized specialist subcontractor which has proven satisfactory experience in work of this type and magnitude and have completed a minimum of five wick drain installation projects in the last five years, each project with the following characteristics:

- Installation depth: not less than 5m
- Total length of wick drains: not less than 20,000m

#### **1.3 DEFINITIONS**

**Quality Verification Engineer:** means an Engineer with a minimum of five (5) years experience related to the design and/or construction of wick drains systems of similar scope to that in the Contract, or alternatively has demonstrated expertise by providing satisfactory quality verification services for the work at a minimum of two (2) projects of similar scope to the Contract. The Quality Verification Engineer shall be retained by the Contractor to ensure conformance with the contract documents and issue of certificate(s) of conformance.

### **2.0 SITE CONDITIONS**

The Contractor shall refer to the following reports in for a description of subsurface conditions at this site:

- Foundation Investigation Report for Fill Embankment in Settlement Area, Highway 401/CPR Overhead Structure Removal (February 2001)

The Record of Borehole sheets are not represented as a complete description of the subsurface conditions, but only present what was found in borings at the indicated locations on the date boreholes were drilled. The subsurface conditions may be variable between the borehole locations. The Contractor should make his own verification of the subsurface conditions.

### **3.0 MATERIALS**

- 3.1 The prefabricated drain shall consist of a continuous plastic drainage core wrapped in a non-woven geotextile material. The core configuration should be 'Studded' or 'Grooved' ('Filament' or 'Cusped' are not acceptable).

Fabricated wick drain material shall meet the minimum Specifications included in the table attached at the end of this text.

- 3.2 The Contractor shall submit a 1 metre sample of the vertical drain material to the Contract Administrator for information at least one month prior to commencement of work under this item. The sample shall be stamped or labelled by the manufacturer as being representative of the drain material having the specified trade name. Documentation indicating the source of the drain shall be provided.
- 3.3 Manufacturer certification shall be provided for all drain material delivered to the project.
- 3.4 All drains supplied shall be free of defects, rips, holes or flaws. During shipment the drain shall be protected from damage. During on-site storage the storage area shall be such that the drain is protected from sunlight, dirt, dust, mud, debris and any other detrimental substances.
- 3.5 The Contractor shall submit a sample of the vertical drain material to the Quality Verification Engineer for review. The Contractor shall submit to the Contract Administrator a Certificate of Conformance sealed and signed by the Quality Verification Engineer a minimum of one week prior to commencement of work under this item. The Certificate shall state that the vertical drain material is in conformance with the requirements and specifications of the contract documents.

### **4.0 EQUIPMENT**

- 4.1 Vertical drains shall be installed with equipment which will minimise disturbance to the Peat Replacement Material or the native subsoil during the installation operation. Static or vibratory methods are considered acceptable. Falling weight impact hammers will not be allowed.



- 4.2 The Contractor is advised that the site is considered as an environmentally sensitive area and therefore the control of any water effluent needs to be carefully planned and organized. Jetting techniques, therefore, shall be subject to the approval of the Contract Administrator.
- 4.3 The Contractor shall be permitted to use augering equipment to predrill or to loosen the native soils and the Peat Replacement material if required to facilitate the installation of the wick drains.
- 4.4 Each prefabricated wick drain shall be installed using a mandrel or sleeve which shall be advanced through the underlying soil and the granular blanket. The mandrel shall protect the prefabricated drain material from tears, cuts and abrasions during installation and shall be withdrawn after the installation on the drain. The mandrel shall be provided with an "anchor" rod or plate at the bottom to prevent the soil from entering the bottom of the mandrel during installation of the drain and to anchor the bottom of the drain at the required depth at the time of mandrel removal. The cross-sectional area of the mandrel and anchor combination (projected onto a plane perpendicular to the axis of the mandrel) shall not exceed 7700 mm<sup>2</sup>.

## 5.0 INSTALLATION

### 5.1 Installation Method Proposal Submission

The Contractor shall submit details of the sequence and method of installation to the Quality Verification Engineer for review. The submittals shall satisfy the specifications and at a minimum contain the following specific information:

- Size, type, weight, maximum pushing force, and configuration of the installation rig.
- Dimensions and length of mandrel.
- Details of drain anchorage.
- Detailed description of proposed installation procedures.
- Proposed methods for overcoming obstructions.
- Proposed methods for splicing drains.

At least three weeks prior to the installation of the drainage strips, the Contractor shall submit to the Contract Administrator, for information purposes, details of the sequence and method of installation. The submittals shall satisfy the specifications and at a minimum contain the above information as provided to the Contractor's Quality Verification Engineer.

The Contractor shall submit to the Contract Administrator a Certificate of Conformance sealed and signed by the Quality Verification Engineer a minimum of one week prior to commencement of work under this item. The Certificate shall state that the installation procedures are in conformance with the requirements and specifications of the contract documents.

## 5.2 Construction Sequence

Vertical drains shall be installed subsequent to replacement of the peat.

## 5.3 Trial Drains and Monitoring

Prior to the installation of prefabricated drains within the areas designated elsewhere in the contract, the Contractor shall demonstrate that the proposed materials, equipment and installation method produces a satisfactory drain installation in accordance with these specifications. The Contractor will be required to install a total of ten trial drains at locations within the work area as designated by the Contract Administrator.

Upon completion of the ten trial drains, the Contractor shall submit to the Contract Administrator a Certificate of Conformance sealed and signed by the Quality Verification Engineer. The Certificate shall state the number and locations of the trial drains that are in conformance with the requirements and specifications of the contract documents.

Should the ten trial drains be installed to the satisfaction of the Contractor's Quality Verification Engineer, the trial drains can be incorporated as part of the permanent installation. The Contractor will be compensated for each trial drain if the installation satisfies the requirements of this specification, at the same unit price as the production drains. The Contractor shall not be compensated for unsatisfactory trial drains.

Full-time monitoring of the Contractor's method of installation will be required by the Contractor's Quality Verification Engineer. If, at any time, the Contractor's Quality Verification Engineer considers that the method of installation does not produce a drain which satisfies the project requirements, the Contractor shall alter his method and/or equipment as necessary to comply with these specifications.

The Contractor shall submit to the Contract Administrator Certificates of Conformance sealed and signed by the Quality Verification Engineer upon completion of each day's production, or each 7000 m of installed drain, whichever quantity is greater. The Certificates shall state that the installed drains are in conformance with the requirements and specifications of the contract documents.



#### 5.4 Layout

Prefabricated drains shall be located and staked out by the Contractor. The location of the drains shall not vary by more than 150 mm from the locations indicated elsewhere in the contract.

#### 5.5 Plumbness

Drains shall be installed vertically, within a tolerance of not more than 10 mm per 500 mm. The equipment shall be carefully checked for plumbness, and the Contractor shall provide the Contract Administrator with a suitable means of verifying the plumbness of the mandrel and of determining the depth of the drain at any time.

#### 5.6 Splices

Splices or connections in the vertical wick drain material shall be carried out in accordance with the specifications of the manufacturer of the wick drains and in such a manner as to avoid any reduction in the flow characteristics of the wick drain material. Unless otherwise specified by the manufacturer, the splice should be at least 150 mm in length.

#### 5.7 Cut-off

The prefabricated drain shall be cut at the surface such that at least a 150 mm length protrudes above the top of the granular blanket at each drain location.

#### 5.8 Obstructions

Where obstructions are encountered below the working surface which cannot be penetrated by the drain installation equipment, the Contractor shall complete the drain from the elevation of the obstruction to the working surface and notify the Contract Administrator. At the direction of the Contract Administrator, the Contractor shall attempt to install a new drain within a 150 mm radius of the correct location. A maximum of two attempts shall be made as directed by the Contract Administrator. The Contractor will be compensated for each obstructed drain unless the drain is improperly completed, in which case no compensation will be allowed. The Contract Administrator shall be the sole authority in determining whether or not a drain has been improperly completed.

#### 5.9 Preaugering

If the Contractor judges that preaugering is required, the drilling shall not extend below the design elevation of the wick drain tips. No additional payment shall be made for pre-auguring.



#### 5.10 Rejected Drains

Prefabricated drains that are installed beyond the plan location by more than 150 mm, or that are damaged or are not installed in accordance with the specifications described above shall be rejected. Rejected drains may be removed at the Contractor's own expense and time. The Contractor shall not be compensated for the materials and work associated with rejected drains.

Replacement drains shall be installed within a 150 mm radius of the correct location or as directed by the Contract Administrator.

### 6.0 **PAYMENT**

#### 6.1 Measurement of Payment

Measurement of the item "WICK DRAINS" is by Plan Quantity, as may be revised by Adjusted Plan Quantity and shall be by the linear metre for all accepted drains installed including the protruding portion.

Properly completed obstructed wick drains and properly installed replacement wick drains and trial drains will be measured for payment.

#### 6.2 Basis for Payment

Item - Wick Drains

Payment at the contract unit price per linear metre for the above item shall be full compensation for all labour, materials and equipment to complete the work in accordance with the Plans and Specifications.

No payment shall be made for unacceptable drains or delays or expenses incurred by the Contractor as a result of improper or unacceptable material or installation.



PRODUCT SPECIFICATIONS FOR WICK DRAINS			
	Test Method	Units	Value
PHYSICAL PROPERTIES			
Drain Body Material		Studded or Grooved	Polypropylene
Filter Material		Non-Woven	Polypropylene
Weight	ASTM-D-1777	g/m	75
Width		mm	not less than 100
Thickness	ASTM-D-5199	mm	not less than 3
Mass of Filter	ASTM-D-1777	g/m <sup>2</sup>	154
MECHANICAL PROPERTIES			
Drain composite Tensile Strength	ASTM D-4595	kN	0.375 @ 10%
Filter Puncture Strength	ASTM-D-751-68	kN	0.335
Filter Grab Strength	ASTM-D-1682	kN	0.8
Filter Trapezoidal Tear	ASTM-D-1117	kN	0.22
Filter Burst Strength	ASTM-D-751-68	kPa	2000
Discharge Capacity @ 70 kPa	ASTM-D4716	m <sup>3</sup> /s	100x10 <sup>-6</sup>
FOS	CAN/CGSB-148.1 No. 10.2	µm	15 to 100
Minimum elongation at break (%)	CAN/CGSB-148.1 No. 7.3	%	15
Water Permeability	ASTM D-4491	m/s	0.000005

PROJECT\2001\10000\11284\wsp WICK DRAINS.doc



